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STANDARDIZATION OF *IN-SITU* MOISTURE CONSERVATION METHOD FOR ESTABLISHMENT OF AONLA ORCHARDS ON SLOPPY DEGRADED WASTELANDS

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ABSTRACT: A study was carried out in Krishi Vigyan Kendra, Deendayal Research Institute, Satna for two consecutive years to evaluate the effect of various *in-situ* moisture conservation measures on establishment and growth of aonla (*Emblica officinalis*) in sloppy degraded lands. *In-situ* moisture conservation measures included for the study were preparation of circular ring basin + mulching the basin with black polythene, staggered contour trenching (45 cm width and 3 m length) on upper side of the plant basin, placement of one submerged pitcher in one side of the plant for rainwater harvesting, setting the seedling in a depression of 1 m width and 15 cm deep, surrounded by a ring-shaped ridge with 25 cm width and 15 cm height and a 30 cm opening on the higher side to harvest rain water + filling the depression with straw + mulching with black polythene and control (no micro- catchment or mulch). The results revealed that all the *in-situ* moisture conservation methods showed improvements in survival, establishment and growth of aonla plants. However, preparation of micro catchment area of one meter width surrounded by ring shaped ridge of 25 cm width and 15 cm height and having a 30 cm opening at the higher side and mulching in depressed area with straw and cover with black polythene was found to be the most effective moisture conservation method in increasing the survival and growth of aonla seedlings/budlings among all the conservation treatments.

Keywords: *Aonla, in-situ moisture conservation, laterite soil, staggered contour trenching.*

The concept of rehabilitation of waste/forest lands through plantations of economic plants on degraded soils for meeting the ever increasing demands of food, fruits, fodder and fuel, has gained widespread attention in India. In recent years, the Central Government of India, as well as some state governments, has expressed their support for bringing degraded lands, which cannot be used for food production, under fruit cultivation. India has vast tracts of wastelands, which have been lying barren for ages. Most of these lands are suitable for growing trees and thus could be put to socially productive uses (Balooni and Singh, 1). However, the major constraint on the pace of expansion of rehabilitation programmes is the non-availability of suitable location specific technologies. Several workers have emphasized the need for development of rehabilitation technology in order to prevent good land from degrading into wastelands, and it has been reported that waste and degraded forest lands can be economically utilized for growing certain economic plants by employing suitable technologies. Hegde (3) reported that soil and water conservation measures and growing trees could effectively rehabilitate such sloppy wastelands. Similarly, attempts to rehabilitate degraded lands in the western Himalayas, Khybri *et al.* (4) found that *in-situ* moisture conservation techniques along with use of grasses, plantation of fuel, fodder and fruit trees were quite effective in rehabilitating denuded lands. Singh (8) studied the performance of certain fruit trees on wastelands in the Bundelkhand region and found that the abundant hilly wastelands available in the region could be successfully developed for the plantation of fruits.Tyagi and Yadava (9), while working on rehabilitation of wastelands, observed that wastelands can be rehabilitated to a greater extent by employing suitable soil-water conservation measures; planting

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of fruit, fodder and fuel tree species, and grafting of improved varieties of fruits on native root stocks. Pareek *et al.* (7) suggested the requirement of soil and water conservation treatments for production of horticultural crops on undulating hilly lands and degraded forest lands.

The aonla (*Emblica officinalis* Gaertn) is one of the most important minor fruits that has bright prospects for extending its cultivation, especially in waste/forestlands where the cultivation of other crops is arduous and less profitable. During the recent years, this crop is fast gaining ground on account of its drought hardiness, high medicinal and nutritional value, non-perishable nature of the fruit, readily available market and high remuneration. Due to its increasing demand in *Ayurvedic* medicines, an expansion of the area under its cultivation has become necessary to meet the demands of pharmaceutical companies. Keeping in view the diverse medicinal use of aonla and its increasing commercial significance in the country, there is an urgent need to give immediate attention towards problems and prospects in its cultivation. However, the greatest bottleneck in its expansion is the poor survivability of plants on waste/forestland. The poor establishment of plants after transplanting is a major problem in the expansion of area under cultivation as heavy mortality (up to 50 %) occurs after transplanting from nursery to field at distant places. Although, aonla is a drought hardy fruit crop, yet the plants require watering during the initial stage of orchard establishment (Pareek, 6). But providing irrigation is neither practical nor economical in the sloppy wastelands. Harvesting of rainwater and *in-situ* moisture conservation is the only viable alternative to artificial irrigation. Scientific information to establish a standard method of rainwater harvesting technology for aonla is inadequate, especially for the sloppy lands. Therefore, an experiment was laid out to study the effect of different models of rain water harvesting on plant survival and growth ratios.

MATERIALS AND METHODS

The experiment was conducted during two consecutive years of 2005-06 and 2006-07 at instructional farm of Krishi Vigyan Kendra, Satna on sloppy wastelands with five *in-situ* moisture conservation methods. The experiment was laid out in a Randomized Block Design with three replications and 20 plants in each replication. The experiment site was cleared off all the shrubs/bushes in the month of May during both the years. Pits of 90 x 90 x 90 m^3 size were dug out during May. The pits were filled with a mixture of good soil and FYM in the ratio of 1:1. Experiment was laid out in a triangular system at a planting distance of 5x5m. The seeds extracted from matured *desi* aonla after treatment with carbendazim (0.25%) were sown in polythene bags (25x10 cm size) filled with a mixture containing soil, sand and FYM in equal proportion for raising seedlings/rootstocks in the last week of June. 2-3 healthy seeds were sown in each polybag. After germination only one healthy seedling was retained per poly bag. After one month the seedlings raised in polybags were transplanted in pits subjected to different *in-situ* moisture conservation measures. These transplanted seedlings were patch budded with NA-7 during the last week of June in the following year. The observations on seedlings growth (height and diameter), survival, time taken for initiation of bud sprout, time taken for completion of 50% buds sprouting, per cent bud sprouting and survival of budlings were recorded. The data on seedlings height and diameter were recorded at monthly interval after transplanting until June of the following year (the time of performing budding operations). The height was measured from the surface of soil to the terminal bud of the main axis, and expressed as average height per seedling in cm. The diameter was recorded at a height of 5 cm from the ground level with the help of a slide vernier caliper, and was expressed as average diameter per seedling in cm. The number of seedlings surviving in each treatment until June of the following year was considered as survival of seedlings. The data on bud sprout were recorded daily after one week of budding. The number of buds sprouted in each

treatment were counted and expressed in percentage on the basis of the number of buds sprouted out of the seedlings budded. The period from the date of budding/grafting to the sprouting of first bud was considered as the time taken for initiation of bud sprout and the period from the date of budding/grafting to the sprouting of 50% buds was considered as the time taken for completion of 50 per cent bud sprouting. The number of budlings surviving in each treatment until 24 weeks after budding were considered as bud survival and expressed in percentage. The data in percentage were transformed to *arc sine* values for calculating the analysis of variance. The details of treatments used are given in Table 1.

Table 1: Treatment details and specification of *in-situ* moisture conservation measures.

Treatments	Specifications
T_1 : Polythene mulching	Preparation of circular ring, and mulching the basin with black polythene.
T_2 : Trench + straw mulching	Staggered trenches of 3m length, 0.45 m width and depth across the slope were prepared in a aligned contour. Half of the trench was filled with straw and the plants were planted on the downstream side of the trench bund.
T_3 : Submerged pitcher	Placement of one submerged pitcher on upper side of the plant for rainwater harvesting.
T_4 : Pit depression	Seedlings were set in a depression of 1 m width and 15 cm depth, surrounded by a ring-shaped ridge with 25 cm width and 15 cm height and a 30 cm opening on the higher side to harvest rainwater. The depression was filled with straw and covered with black polythene as mulch.
T_5 : Control	Control (no micro-catchments and no mulch).

RESULTS AND DISCUSSION

Seedling Growth

The data on the effect of different *in-situ* soil moisture conservation treatments on plant growth and survival over the years are presented in Table 2. The pooled analysis of variance for plant height, diameter and survival percentage revealed significant differences among different soil moisture conservation methods, and strongly indicated the significance of rainwater harvesting and *in-situ* moisture conservation The results of the present studies revealed that rainwater harvesting and *in-situ* moisture conservation is a must for better establishment and development of aonla seedlings/budlings particularly in sloppy degraded soils, as the growth and survival of aonla plants was markedly improved when the seedlings/budlings were subjected to different *in-situ* moisture conservation methods.

In the present studies, the seedling growth in terms of height and diameter was influenced significantly by different *in-situ* moisture conservation treatments. Among all the treatments, transplanting of seedlings in pit depression (T_4) resulted in the maximum seedling height (89.54 cm) and diameter (1.11 cm), which was significantly greater than the other treatments. The next best treatment in respect of seedling growth was *in-situ* moisture conservation by staggered trench + straw mulching (81.24 and 1.05 cm) and submerged pitcher (77.23 and 1.02 cm). The control plants recorded significantly lowest plant height (66.44 cm) and diameter (0.96 cm). The difference in the response of growth parameters to various *in-situ* moisture conservation treatments was purely due to differences in the moisture holding and retaining efficiency of treatments. Better growth of the seedlings planted in a pit depression may be due to more soil moisture

available for longer periods. These findings are in conformity with the results of Ghosh *et al.* (2), where they also noted better growth of the aonla plants in pit like depressions.

The data further revealed that the trend in increase in seedling's height and diameter in response to different *in-situ* moisture conservation techniques was almost similar during both the years of investigations.

Seedling Survival

Another beneficial effect of *in-situ* moisture conservation was significant improvement in plant survival. All the treatments except polythene mulching recorded significantly higher plant survival percentage over the control. The treatments, planting the seedlings in pit depression, and just below the staggered contour trench, were found to be more effective in increasing the survival percentage of seedlings than other treatments. The treatment establishing seedlings in pit depression (T_4), recorded the mean maximum plant survival (93.75 per cent), which was statistically at par with staggered trench + straw mulching (89.38 per cent). The lowest plant survival was recorded under polythene mulching (69.38 per cent), which was at par with control.

These results are in conformity with the findings of Manivannan and Desai (5), who also recorded the maximum survival of plants (89.4 per cent) with staggered contour trenching method of rainwater harvesting, as against 52 per cent under control and observed that the treatments which enhanced growth also improved the survival rate of the plants.

Bud Sprout and Bud Survival

The data on the effect of different rainwater harvesting and moisture conservation techniques on bud sprouting and bud survival percentage are presented in Table 3. The bud sprouting and bud survival percentage were influenced significantly by the different methods of soil moisture conservation. The maximum sprouting (83.75 per cent) as well as bud survival (80.82 per cent) was recorded in seedlings set in pit depression, followed by seedlings planted just below the staggered trench and submerged pitcher methods of moisture conservation. These observations thus indicate that the survival of budlings can be improved greatly by employing *in-situ* moisture conservation methods. These observations are in conformity with the findings of Manivannan and Desai (5), who reported that bud sprouting and survival of plants was improved by moisture conservation methods.

Table 2: Effect of *in-situ* moisture conservation methods on height, diameter and per cent survival of Aonla seedlings.

Treatment	Seedling Height (cm)			Seedling Diameter(cm)			Survival (%)		
	2005-06	2006-07	Mean	2005-06	2006-07	Mean	2005-06	2006-07	Mean
T_1 : Polythene mulching	68.92	74.04	71.48	0.92	0.98	0.95	73.75 (59.18)	76.25 (60.83)	75.00 (60.00)
T_2 : Trench + straw mulching	75.74	86.74	81.24	0.99	1.09	1.05	87.50 (69.29)	91.25 (72.79)	89.38 (70.98)
T_3 : Submerged pitcher	71.97	82.50	77.23	0.95	1.08	1.02	87.50 (69.29)	87.50 (69.29)	87.50 (69.29)
T_4 : Pit depression	84.67	94.41	89.54	1.04	1.17	1.11	92.50 (74.11)	95.00 (77.08)	93.75 (75.52)
T_5 : Control	64.73	68.16	66.44	0.85	0.96	0.91	68.75 (56.01)	70.00 (56.79)	69.38 (56.40)
CD (P=0.05)	4.64	3.51	2.49	0.11	0.06	0.06	6.98	7.95	5.11

Table 3: Effect of *in-situ* moisture conservation methods on bud sprouting and bud survival in Aonla.

Treatment	Bud Sprouting (%)			Bud Survival (%)		
	2006	2007	Mean	2006	2007	Mean
T_1 : Polythene mulching	77.50 (61.68)	67.50 (55.24)	72.50 (58.37)	58.48 (49.88)	63.10 (52.59)	60.79 (51.23)
T_2 : Trench + straw mulching	82.50 (65.27)	72.50 (58.37)	77.50 (61.68)	69.45 (56.45)	75.89 (60.59)	72.67 (58.48)
T_3 : Submerged pitcher	85.00 (67.21)	70.00 (56.79)	77.50 (61.68)	71.53 (57.75)	72.77 (58.54)	72.15 (58.15)
T_4 : Pit depression	90.00 (71.57)	77.50 (61.68)	83.75 (66.23)	78.27 (62.21)	83.38 (65.94)	80.82 (64.03)
T_5 : Control	70.00 (56.79)	55.00 (47.87)	62.50 (52.24)	53.57 (47.05)	55.00 (47.86)	54.29 (47.46)
CD (P=0.05)	10.59	6.53	5.03	7.73	7.89	5.09

The data further reveal that the trend in bud sprouting and bud survival percentage in response to the different rainwater harvesting and *in-situ* moisture conservation methods was similar during the two years.

Time taken for Initiation of Bud Sprouting and 50 per cent Sprouting of Bud

The data pertaining to the effect of different *in-situ* moisture conservation treatments on the time taken for initiation of bud sprouting are presented in Table 4. In the present studies, in-situ moisture conservation methods were observed to cause earlier initiation and earlier completion of 50 % bud sprouting as compared to the control. The minimum time for initiation of bud sprouting (14.0 days) was taken by planting the seedlings in pit depression (T_4) followed by planting seedlings just below the staggered trench. The treatment which resulted in earlier initiation of bud sprouting also caused earlier completion of bud sprouting. The mean minimum time of 24.01 and 24.08 days for sprouting of 50 per cent buds were taken under the plant set in depression (T_4) and staggered trench + straw mulching (T_2), respectively. The earlier bud sprouting and relatively higher bud success in seedlings planted in pit depression and just below the staggered trench may be attributed to better sap flow in these seedlings, which enables the bud to heal quickly and make a strong union. Relatively lower budding success and delayed bud burst in control may be attributed to decreased sap flow and less seedling diameter, which must have ultimately interfered with the process of bud union and its healing.

CONCLUSION

From the results of these studies, it may be concluded that *in-situ* moisture conservation is must for better establishment and development of aonla plants on degraded sloppy lands, as the seedling growth in terms of height and diameter, survival percentage of seedlings, bud sprout and survival percentage of budlings were significantly improved when the plants were subjected to different *in-situ* moisture conservation methods. Among the different methods of *in-situ* moisture conservation, the treatment of planting one month old polythene raised seedlings in a pit depression of 1 m width and 15 cm deep, surrounded by a ring-shaped ridge with 25 cm width and 15 cm height and a 30 cm opening on the higher side to harvest rain water and filling the depression with straw and covering the pit with black polythene and performing patch budding next year during end of June, which resulted in maximum seedling

Table 4: Effect of *in-situ* moisture conservation methods on time taken for sprouting of buds in Aonla.

Treatment	Time taken for initiation of bud sprout			Days taken for 50% sprouting of buds		
	2006	2007	Mean	2006	2007	Mean
T_1 : Polythene mulching	14.75	16.25	15.50	25.13	26.55	25.84
T_2 : Trench + straw mulching	12.75	16.00	14.38	22.45	25.70	24.08
T_3 : Submerged pitcher	13.00	15.75	14.38	22.75	25.78	24.26
T_4 : Pit depression	12.50	15.50	14.00	22.53	25.50	24.01
T_5 : Control	16.00	16.75	16.38	25.48	27.05	26.26
CD (P=0.05)	NS	NS	NS	2.48	NS	NS

growth and plant survival found to be the best *in-situ* moisture conservation method and may be recommended for rehabilitation of degraded sloppy lands.

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PERENNIAL CHILLIES GERMPLASM IDENTIFIED AND EXPLORED FROM BIHAR

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ABSTRACT: Quality seeds are the indispensable material for successful crop production. Germplasm resource contains unique traits/genes that can be utilized for further crop improvement. Exploration for collection of germplasm is the quickest and simplest method for acquiring the desired one. Perennial type of chillies has been identified and explored from WALMI Research farm of ICAR Research Complex for Eastern Region Patna (Bihar). This unique germplasm has been entered in the seventh successive years of successful fruiting. Such distinctive genotype could be a great value for kitchen garden purpose, particularly in the era of nucleus family. Such promising and unique germplasm can be utilized by chillies worker in their respective on going/ensuing crop improvement programme to reinforcement food and nutritional security of country by efficient utilization.

Keywords: *Exploration, germplasm, chillies, perennial, vegetable.*

Chillies (*Capsicum annuum* L.), belongs to the Hungarian world of plants confined in the family Solanaceae, belongs to the genus *Capsicum* with chromosome number of 24 (Ashokkumar *et al.,* 4; and Brian *et al.,* 8). Chillies peppers have been a part of the human diet in the Americas since at least 7500 BC. Chillies peppers originated in South and Central America, where they were used by the native inhabitants for thousands of years. There is archaeological evidence at sites located in south-western Ecuador that chillies peppers were domesticated more than 6000 years ago (BBC, 5). A chilli is one of the first cultivated crops in the Central and South Americas (Bosland, 6) that is self-pollinating. From South and Central America, it travelled to Europe after Columbus's voyage to Mexico in 1492 and later on spread to all over world (McClung, 12 and Pickersgill, 14). It is rich source of vitamin A and C (ascorbic acid). Vitamin C was first isolated from chillies plant. It is one of the most valuable commercial annual spice crop grown in India. Presently, India is the largest producer of chilli in the world owing to the availability of improved varieties (Dash *et al.,* 9). In India chilli is grown over an area of 7.67 lakh hectares with the production of 12.03 lakh tonnes and productivity of 1568 kg dry chilli per hectare, (Anonymous, 2). Presently huge number of chillies varieties available varying in their pungency right from mild sweet peppers, to the viciously hot. Hotness of the chilli is measured in Scoville units. A relatively mild pepper, such as the Jalapeno commonly found in Salsas, measures around 5000 Scoville units, depending on individual variety and growing conditions (Basland and Vostava, 7). The hottest peppers, like the Habanero and Serrano, measure between 80,000 and 300,000 Scoville units (Kosuge *et al.,* 11 and Tembhurne and Rao, 18). Chillies, in general behave like annual and for commercial cultivation, it is grown as annual crop in all over the world. Though, life cycle of chilli is basically governed by the climatic condition. If it is grown in temperate climate it is essentially annual in nature, whereas, if it is grown in tropical condition especially in most areas of north of the equator, plants may behave like perennial, though they are grown as annuals plants. Though some marked as annuals can be grown as perennials indoors or in greenhouses (Aguilar-Meléndez, 1; and Pickersgill, 13 and 15). Though perennial behaviour of chillies is reported by several workers but its economical sustainability was not much studied due very easy in propagation through seedling raising. This peculiarity was the main

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Fig. 1. Full and closeup view of six year old chilli plant.

focal point to undertake study on its perennial behavioural study.

MATERIALS AND METHODS

An extraordinary plant type of chilli was identified at the research farm WALMI, of ICAR Research complex for Eastern Region Patna and this distinct plant type was marked for regular visit. The source of this unique germplasm was a farm staff, who procured local chillies sapling from local market for his kitchen garden purpose. Actually this plant was a second generation plant transplanted from the seedling raised from the crop already harvested from kitchen garden. Initially up to 3 years general ward and watch was maintained by the farm worker who used to pick chillies fruits for their consumption purpose during their lunch. In general chillies are cultivated as annual for commercial purpose, across the globe. However perennial nature is reported in this genus, though this phenomenon is limited to the tropics especially places near to equator (Jovicich and Cantliffe, 10; and Aguilar-Meléndez, 1). Since, 2-3 fruiting seasons is often, but obviously, when this plant did not shown any symptoms regarding completion of its lifecycle, we started taking care in a cavalier fashion, up to 4 years. Since, 5th year onwards, regular training and pruning was taking place (Fig. 1 and Fig. 2a, 2b). Regular, watering and weeding was carried out, required dose of NPK and FYM was supplement to maintain uninterrupted supply of essential nutrient on regular basis. Urea was supplement at 25 days intervals, whereas P and K was supplemented at the interval of six month only. No major incidence of pests and diseases were noticed, though profilecting measure was taken well in advance to avoid any such incidence. Yearly soil sample were analysed to know the soil health status. Since the soil is sandy loam in texture, FYM has been added regularly. Training and pruning of the plant was done in a such way that at least one branch is always maintained at lower level near the ground and other non productive were kept out

(Ara *et al.,* 3). Plant is still active and bearing fruits on regular basis. Since 2009, when perennial nature was confirmed, data were recorded for growth, development yield attributes and chillies yield regularly and computed on yearly basis. It worth to mention here that data for first and second year was generated by raising crop from seed harvested from this plant and the plant was maintained for two years.

RESULTS AND DISCUSSION

Visual observation was taken place for initial period of three years, and when it was come to the notice that this plant is behaving like perennial and completed successfully three years of fruiting on regular basis. It was observed that plant behave like indeterminate growth habit. It is worth to mentioned that this plant by and large its phenology does not influenced by the seasons, temperature and photoperiod. Seem to be photo-thermal insensitive plant. It is but obvious that performance of plant little bit slowdown during extreme cold and hotter months of the years especially during scratchy wind during mid May to mid June.

Fig. 2a. Chillies fruit.

Fig. 2b. Closeup of fruiting twig.

Data recorded during all the six years (Table 1) reveals that plant height of this chilli plant increased with the advancement of the age. At the end of first year it attains the height of 38.6cm only. Plant achieved its height of 148.2 cm at the end of six year. Annual fruit production by the plant was increased with the age. Minimum (336 fruits) was recorded for first year and maximum (1117 fruits) for the sixth year production. Likewise green fruits yield was also followed the similar trend. At the end of first year green fruits yield was recorded 1077g only which increased with age and maximum 3607g was recorded at the end of sixth year. It was recorded that fruit length was not influenced by the age of plant, though it was categorized as medium size (Table 1). Similarly single fruit weight also did not influenced much with passing of time (age). Fruit length and single fruit weight did not influenced by the age, this might be due to traits is highly associated with genotype, not much influenced by the age or environment confirming to findings of Singh and Bhatt (17).

To know the changes in soil fertility status, soil samples were taken at regular interval starting from June, 2007 and latest by June, 2012. Soil samples were analysed to workout initial and final soil fertility status to know the nutrient dynamic in soil of the perennial chilli plant (Ryan *et al.,* 16). Data (Table 4), represent initial and final soil properties physical parameters viz., sand, silt and clay composition of soil was not much influenced by the chilli. Bulk density of soil also did not change. However, other parameter related to soil fertility gets influenced. N, P and K were improved significantly (Table 2). Since chilli is endowed with professed root system, encourage more rhizospher microbial activities, substantial nutrient build-up was noticed. Above results indicate that chillies plants can be grown easily without impairing the fertility status of soils.

Table 1: Growth, yield attributes and yields of yield of chillies plant during different years.

Years	Plant height (cm)	Fruit length (cm)	Fruit (No/ plant)	Single fruit weight (g)	Green fruits yield (g/ plant)
Ist	38.6	7.53	336	3.21	1077
2nd	69.5	7.38	526	3.21	1689
3rd	91.2	7.56	774	3.11	2408
4th	115.3	7.43	921	3.16	2910
5th	129.6	7.31	1115	3.09	3445
6th	148.2	7.44	1117	3.23	3607
CD (P=0.05)	14.9	NS	57.4	NS	201.3

Fig. 3a. One year old chilli plant

Fig. 3b. Two year old chilli plant.

Table 2: Physiochemical properties of chilli soil.

Value	Sand (%)	Silt (%)	Clay (%)	Soil pH	Organic carbon (%)	Bulk Density (m m^3)	Electrical Conductivity (dSm^{-1})	NO_3 (ppm)	Available Phosphorus (ppm)	Exchangeable Potassium (ppm)
Initial	33.1	36.4	30.5	7.4	0.61	1.42	0.17	113.7	12.1	87.8
Final	32.5	36.3	31.2	7.1	0.68	1.40	0.15	131.9	13.4	97.3

CONCLUSION

Unique germplasm, exploration for collection of desired traits not only strengthen and diversify the gene pool of particular crop, but also proves a quickest as well as simplest method of achieving objective of creating variability. Exploration for collection should be an integral part of any plant germplasm augmentation programme. Biennial nature is often but a perennial chilli is not a business as usual phenomenon. Successful fruiting for six years and entered in to seventh year is not a normal and simple event. This plant type is definitely carrying /containing some unique gene

and expressing their potential for regular fruiting. This genotype behaves like photo and thermal insensitive line. Such potential germplasm should be deposited in National Gene Bank for safe conservation and nationwide uses in crop improvement programme.

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FOLIAR APPLICATION OF POTASSIUM, CALCIUM, ZINC AND BORON ENHANCED YIELD, QUALITY AND SHELF LIFE OF MANGO

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ABSTRACT: Mango, the national fruit of India, has developed its own importance all over the world. Being a useful and delicious fruit, it is the part of culture and religion since long time, and now, it is recognized as one of the best fruits in the world market. Calcium and potassium amongst major nutrients as well as zinc, boron amongst micro nutrients have been found to play a major role in maintenance of mango fruit quality. Moreover, for rapid response and correction of deficiencies of mineral nutrients, foliar spray of nutrients especially Ca, B, Zn and K have been used singly or in combination. The experiment was conducted on mango cv. Dashehari at Horticulture Research Centre, Patharchatta, G.B. Pant Univesity of Agriculture and Technology, Pantnagar. The experiment involved the pre-harvest foliar spray of nutrients at 'marvel stage' of mango fruits. The treatments included $CaCl_2$@1.2%, Borax@0.5%, K_2SO_4 @ 0.5%, Ca $(NO_3)_2$@1.0%, $ZnSO_4$@0.5%, $ZnCl_2$@0.3% and control. The results obtained indicated that the trees sprayed with 0.5% borax showed maximum fruit yield, fruit weight, fruit volume, T.S.S., reducing sugar, non reducing sugar and ascorbic acid content, however, this treatment found to be at par with 1% $Ca(NO_3)_2$. While with regard to maintenance of post harvest fruit quality in mango, the minimum physiological loss in weight was reported in 1.0% $Ca(NO_3)_2$ followed by $CaCl_2$ (1.2%) up to the end of 12th day. Other quality parameters like fruit TSS, sugar and ascorbic acid content were best maintained by borax, calcium and potassium treatments.

Keywords: *Foliar application, Ca, B, Zn, K, mango, quality, shelf life.*

Mango is the national fruit of India and is the major fruit of Asia. It has developed its own importance all over the world. Being a useful and delicious fruit, it is the part of culture and religion since long time. From ancient time, it has been the favourite of the kings and commoners because of its nutritive value, taste, attractive fragrance and health promoting qualities and now, it is recognized as one of the best fruits in the world market. Calcium is an important nutrient, plays a crucial role in several physiological functions viz., fruit firmness retention, protecting the plant against salinity stress, callus friability and somatic embryogenesis. Romero *et al.* (18) found that the application of calcium as pre-harvest spray increased fruit quality of mango fruit. Singh *et al.* (22) reported that the Calcium nitrate at lower concentration i.e. 1.0% showed beneficial effects in prolonging the storage life of guava fruits. Boron also affects fruit maturity and quality. According to Chapman *et al.* (6), the fruits from the boron deficient papaya plants ripen unevenly and have low sugar content. Aly and Isamail (1) reported that boron as pre harvest spray has beneficial effect on quality of guava fruits. Moreover, for rapid response and correction of deficiencies of mineral nutrients, foliar feeding of nutrients especially Ca, B, Zn, and K, singly or in combination, is beneficial for accelerating development of growth characters, flowering, fruiting, quality and shelf life of fruits.

MATERIALS AND METHODS

The present investigation was carried out at Horticulture Research Centre, Patharchatta of G.B. Pant University of Agriculture and Technology, Pantnagar during 2008 (January to July). The pre-harvest foliar spray of nutrients on 6 years old trees of mango cv. Dashehari was done at marvel stage of fruits, planted at a distance of 10x10m. The experiment was consisted of eight treatments viz. T_1-1.2% $CaCl_2$, T_2-0.5% Borax, T_3-0.5% K_2SO_4, T_4 -1.0% $Ca(NO_3)_2$, T_5-0.5% $ZnSO_4$, T_6-0.3% $ZnCl_2$, and T_7-control with three replications in randomize block design. There was single tree per treatment

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per replication. The fruits were harvested at mature stage and five fruits were taken from each tree for recording data on physical and chemical attributes of fruits. Physiological loss in fruit weight (PLW) and chemical attributes were recorded at every 2 days interval up to the end of shelf life at ambient storage. The T.S.S. of fruit was recorded at room temperature using hand refractometer and it was expressed in °Brix and chemical quality attributes were determined as per standard procedure decribed in AOAC (2).

RESULTS AND DISCUSSION

Effect on fruit weight, fruit volume and fruit yield

The data presented in Table 1 revealed that significantly higher fruit weight (167.29 g) and fruit volume (164.52 ml) were observed with the treatment of 0.5% borax which was found statistically at par with treatment 1.0% $Ca(NO_3)_2$ (163.41g and 160.11ml) and 1.2% $CaCl_2$ (157.86g and 154.84 ml), while minimum (143.99 and 139.04 ml) was in control. Appreciable improvement in fruit weight by borax application has been also reported by Dutta *et al.* (8) in litchi and Dutta (7) in mango cv. Himsagar. The increase in fruit weight with the sprays of borax was might be due to the involvement in hormonal metabolism, increase in cell division and expension of cell. Boron is also known to stimulate rapid mobilization of water and sugar in the fruit.

The maximum fruit yield (28.52 kg/tree) was recorded with the treatment of 0.5% borax as compared to other treatments and minimum in control. Bhatia *et al.* (5) reported maximum fruit weight and consequently the yield of guava with the application of 1.0% H_3BO_3. Increase in fruit weight, fruit volume and fruit yield in mango cv. Dashehari as pre-harvest application of 0.5% borax was reported by Gaya (9). The significant increase in yield by boron application may be accredited to the positive effect of boron on increasing the rates of carbohydrate and RNA metabolism (Parr and Loughman, 16).

Effect on T.S.S., reducing sugar, non reducing sugar and ascorbic acid

A perusal of Table 2 showed that foliar sprays of nutrients had significant effect on TSS content of mango fruits for different treatments. Maximum T.S.S content (17.8 °B) was recorded in 0.5% borax, whereas, it was found minimum in control (14.65 °B). Similar results have also been obtained by Dutta (7) in guava and Gaya (9) in mango. The increase in T.S.S. up to certain period signified the period of active synthesis of carbohydrates in fruits, while declining trend in T.S.S followed thereafter, indicated the degradation and fermentation of sugars signaling the onset of senescence stage (Ryall and Pentzer, 19).

Data indicate the maximum reducing sugar content (6.42 per cent) in treatment with 0.5% borax which was found statistically at par with 0.5% $ZnSO_4$ (5.64 per cent) and 1.2% $CaCl_2$ (5.5 per cent), respectively (Table 3) and minimum in control (4.30 per cent). Similar results have been obtained by Gaya (9). Kahlon and Uppal (11) suggested that conversion of starches and polysaccharides into simple sugar with the advancement of storage was responsible for the increase of reducing sugar, and onward decline was due to the utilization of sugar in evapo-transpiration and other biochemical activities.

Non reducing sugar was reported to be maximum (9.29 per cent) in fruits treated with 0.5% borax which was found statistically at par with 1.2% $CaCl_2$ (8.86 per cent), 1.0% Ca $(NO_3)_2$ (8.73 per cent) and 0.5% $ZnSO_4$ (8.36 per cent) whereas, it was found to be minimum (6.58 per cent) in control (Table 4). These results elucidated the findings of Babu and Singh (3) and Dutta (7). It was observed that the proportion of reducing sugar content was less as compared to non reducing sugar both at ripe and at the end of shelf life supporting the findings of Sudhavani and Ravisankar (23).

It is revealed from the Table 5 that significantly maximum ascorbic acid content (34.05 mg/100g pulp) was recorded in 0.5% borax

Table 1: Effect of pre harvest foliar spray of nutrients on fruit yield and physical quality attributes of mango cv. Dashehari.

Treatment	Fruit weight (g)	Fruit volume (ml)	Fruit yield (Kg/Tree)
T_1 $CaCl_2$ (1.2%)	157.86	154.84	25.73
T_2 Borax (0.5%)	167.29	164.52	28.52
T_3 K_2SO_4 (0.5%)	149.74	144.03	23.86
T_4 $Ca(NO_3)_2$ (1.0%)	163.41	160.11	26.67
T_5 $ZnSO_4$ (0.5%)	154.72	149.06	24.22
T_6 $ZnCl_2$ (0.3%)	147.95	143.12	22.54
T_7 Control	143.99	139.04	20.95
C.D. (P = 0.05)	11.73	12.32	1.06

Table 2: Effect of pre harvest foliar spray of nutrients on PLW of mango cv. Dashehari at ambient storage.

Treatments		Initial fruit weight (g)	Physiological loss in weight (%) at different storage period (days)						
			3 days	4 days	6 days	8 days	10 days	12 days	Mean
T_1	$CaCl_2$ (1.2%)	160.44	5.67	9.26	11.73	18.42	25.59	30.33	16.83
T_2	Borax (0.5%)	183.96	5.92	10.27	14.22	22.12	27.48	34.62	19.11
T_3	K_2SO_4 (0.5%)	154.05	6.32	8.76	12.65	17.87	26.28	32.75	17.44
T_4	$Ca(NO_3)_2$ (1.0%)	175.39.	5.40	8.60	11.61	17.36	25.12	30.22	16.39
T_5	$ZnSO_4$ (0.5%)	146.98	6.42	10.41	14.51	20.17	26.73	33.46	18.62
T_6	$ZnCl_2$ (0.3%)	138.08	6.77	10.71	14.77	19.30	27.84	33.87	18.88
T_7	Control	125.14	7.50	11.77	15.23	22.81	28.43	36.36	20.35
Mean		—	6.29	9.97	13.53	19.72	26.78	33.09	
		Storage days			Treatment		Storage days x Treatment		
C.D. (P=0.05)		0.79			0.85		NS		

Table 3: Effect of pre harvest foliar spray of nutrients on TSS (°Brix) of mango cv. Dashehari at ambient temperature.

Treatments		Storage period						
		0 day	2 days	4 days	6 days	8 days	10 days	Mean
T_1	$CaCl_2$ (1.2%)	9.53	12.67	17.60	20.27	19.23	18.67	16.32
T_2	Borax (0.5%)	11.40	15.40	18.73	21.67	20.03	19.57	17.80
T_3	K_2SO_4 (0.5%)	9.33	12.40	15.70	18.60	17.50	16.67	15.03
T_4	$Ca(NO_3)_2$ (1.0%)	10.20	13.80	16.53	19.87	18.27	17.80	16.07
T_5	$ZnSO_4$ (0.5%)	8.40	14.04	18.23	20.03	19.80	18.00	16.47
T_6	$ZnCl_2$ (0.3%)	8.16	13.57	17.30	19.30	18.17	17.40	15.65
T_7	Control	7.47	12.00	16.30	18.17	17.40	16.56	14.65
Mean		9.21	13.46	17.20	19.70	18.62	17.80	
		Storage days		Treatment		Storage days x Treatment		
C.D.(P=0.05)		1.07		1.15		NS		

Table 4: Effect of pre harvest foliar spray of nutrients on reducing sugar (%) of mango cv. Dashehari at ambient storage.

Treatments		Storage period						
		0 day	**2 days**	**4 days**	**6 days**	**8 days**	**10 days**	**Mean**
T_1	$CaCl_2$ (1.2%)	2.19	3.34	6.30	7.54	7.12	6.92	5.57
T_2	Borax (0.5%)	2.97	5.82	7.25	7.78	7.55	7.15	6.42
T_3	K_2SO_4 (0.5%)	2.06	4.09	4.84	6.64	6.31	6.19	5.02
T_4	$Ca(NO_3)_2$ (1.0%)	2.17	4.46	5.49	7.23	6.37	6.28	5.33
T_5	$ZnSO_4$ (0.5%)	1.59	5.55	6.62	6.83	6.65	6.57	5.64
T_6	$ZnCl_2$ (0.3%)	1.73	4.83	7.13	6.30	5.86	5.47	5.22
T_7	Control	1.54	3.38	4.16	5.80	5.77	5.12	4.30
Mean		2.04	4.50	5.97	6.87	6.52	6.24	
C.D.(P=0.05)		Storage days 0.99		Treatment 1.07		Storage days Treatment NS		

Table 5: Effect of pre harvest foliar spray of nutrients on non reducing sugar (%) of mango cv. Dashehari at ambient storage.

Treatments		Storage period						
		0 day	**2 days**	**4 days**	**6 days**	**8 days**	**10 days**	**Mean**
T_1	$CaCl_2$ (1.2%)	5.30	7.45	9.10	10.98	10.46	9.85	8.86
T_2	Borax (0.5%)	5.38	7.85	9.33	11.86	10.91	10.42	9.29
T_3	K_2SO_4 (0.5%)	4.26	5.65	7.87	9.74	9.48	8.94	7.66
T_4	$Ca(NO_3)_2$ (1.0%)	4.46	6.94	8.73	11.13	10.78	10.32	8.73
T_5	$ZnSO_4$ (0.5%)	4.30	6.67	8.55	10.74	10.13	9.78	8.36
T_6	$ZnCl_2$ (0.3%)	3.75	5.33	7.58	10.50	9.87	8.14	7.53
T_7	Control	3.10	5.24	6.56	8.84	8.31	7.40	6.58
Mean		4.36	6.45	8.25	10.54	9.99	9.26	
C.D. (P=0.05)		Storage days 0.92		Treatment 1.00		Storage days x Treatment NS		

Table 6: Effect of pre harvest foliar spray of nutrients on ascorbic acid (mg/100 g pulp) of mango cv. Dashehari at ambient storage.

Treatments		Storage period						
		0 day	**2 days**	**4 days**	**6 days**	**8 days**	**10 days**	**Mean**
T_1	$CaCl_2$ (1.2%)	44.62	39.09	34.24	26.50	22.79	18.63	30.98
T_2	Borax (0.5%)	47.62	42.22	37.46	31.26	25.53	20.19	34.05
T_3	K_2SO_4 (0.5%)	43.73	37.58	33.69	25.62	20.46	18.36	29.91
T_4	$Ca(NO_3)_2$ (1.0%)	45.49	42.31	35.37	29.53	24.39	19.73	32.80
T_5	$ZnSO_4$ (0.5%)	43.21	36.68	32.65	24.77	20.68	18.24	29.37
T_6	$ZnCl_2$ (0.3%)	42.31	34.56	31.51	23.30	19.18	17.38	28.04
T_7	Control	40.78	32.77	30.23	21.49	18.13	16.75	26.69
Mean		43.97	37.09	33.59	26.07	21.59	18.47	
C.D.(P=0.05)		Storage days 1.37		Treatment 1.489		Storage days x Treatment NS		

which was found statistically at par with 1.0% $Ca(NO_3)_2$ (32.80 mg/100g pulp), whereas it was found to be minimum (26.69 mg/100g pulp) in control. Higher level of ascorbic acid by application of boron was due to higher content of ascorbic acid as synthesized from sugar. Almost similar results were also reported by Kar *et al.* (2) in pineapple. Losses in ascorbic acid content of fruits were directly proportional to the length of storage period. Mapson (14) suggested that loss in ascorbic acid on prolonged storage is attributed to the rapid conversion of L-ascorbic acid into dehydro-ascorbic acid in presence of ascorbinase enzyme.

Effect on physiological loss in weight

The data presented in Table 6 clearly revealed that minimum loss in weight (16.39 per cent) was recorded in treatment with 1.0% $Ca(NO_3)_2$ which was statistically at par with 1.2% $CaCl_2$ (16.83 per cent PLW), while the maximum loss in weight (20.35 per cent) was reported in control. Similar results have also been obtained by Roychaudhary *et al.* (17) in guava, Saha *et al.* (20) in litchi and Gaya (9) in mango cv. Dashehari. The increase in evapo-transpiration changes with progress of storage period might be responsible for high PLW of fruits as reported by Khader *et al.* (13). The decrease in weight loss by the application of calcium may be due to its role in the maintenance of fruit firmness, retardation of respiratory rates as well as transpiration and delayed senescence (Bangirth *et al.,* 4; Jones *et al.,* 10; Mika, 15; Singh *et al.,* 21).

The pre-harvest foliar spray of nutrients at marvel stage of fruits found to be effective for increase in yield, quality and shelf life of mango cv. Dashehari. However, spray of borax @ 0.5% was effective for yield and quality, while $Ca(NO_3)_2$ @ 1.0% was effective for shelf life of shelf life of mango fruits.

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STUDIES ON THE EXTENT OF GENETIC CONTAMINATION IN SEED PRODUCTION OF EXERTED STIGMA TOMATO (*Solanum lycopersicum* L)

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ABSTRACT: Studies were conducted at the experimental farm of Punjab Agricultural University, Ludhiana, during Rabi season for three years, 2006 to 2010 to standardize the minimum isolation distance required for maintaining genetic purity in hybrid seed production of exerted stigma (recessive) tomato under open field conditions. The exerted stigma seed parent with recessive potato leaved seedling marker was sown at 25 m, 50 m, 75 m, 100m, 150m, 200m and 250m distance away from normal stigma (inserted) contaminator parent cv. Castle Rock having dominant cut leaf seedling marker. The pooled data of three years indicated that the highest percentage of genetic contamination of 9.26% was recorded at a distance of 25 m from the contaminator (Castle Rock). It was also observed that there was a gradual reduction in contamination level with increasing distance at 100m isolation distance of 2.56% although it was not within the prescribed maximum permissible limit of genetic contamination (1 and 2% for foundation and certified seed, respectively). There was zero genetic contamination at the highest isolation distance of 150 m. In the present study, in the isolation distances studied until 100m, the level of contamination was well above the permissible minimum seed certification standards (98 % genetic purity for certified seed). However, based on the present study, the isolation distance required for maintenance of genetic purity of tomato using exerted stigma seed parent for hybrid seed production under open field conditions of Punjab is 150m as against the recommended isolation of 25m and 100m for production of certified seeds of open pollinated seeds and hybrid seeds, respectively.

Keywords: *Tomato, genetic purity, isolation, contamination, seed production.*

Tomato (*Solanium lycopersicum* L) is an important vegetable crop cultivated worldwide owing to its economic significance. In ndia, tomato occupies an area of 6,34,400 ha with a production of 1,24,33,200 mt and a productivity of 19.6 mt/ha (Annon., 1). The projected hybrid seed requirement for regular tomatoes for next five years is 35 t (Annon., 2). Increasing demand for hybrid seeds could stress commercial hybrid seed production abilities (Cheema and Dhaliwal, 6). The impurity of the pollen source by natural crossing could lower the genetic purity of open pollinated and hybrid seeds (Liu *et. al.,* 9). Hence, maintenance of genetic purity in seed production is of critical importance as low genetic purity see would cause heavy loss for the seed producers. Tomato is >99% self pollinated (Groenewegen *et. al.,* 7). The flowers of most commercial cultivars have a short style that places the stigma inside the anther tube assuring self pollination and virtually eliminating the opportunity for outcrossing. On the contrary, although tomato is a self pollinated crop, natural cross pollination of 5% has been reported (Veerarahavathatham *et al*., 12).

An isolation distance of l00 m is required for certified seeds between two tomato varieties to prevent out crossing in hybrid seed production under open field conditions (Tunwar and Singh, 11). In any seed production programme, isolation between two varieties is a pre·requisite to prevent either mechanical mixture/cross pollination for the production of breeder/foundation/ or certified seeds.

Under normal conditions, most tomatoes have a natural cross-pollination rate of about 2 to 5%. Under some conditions though, this may be as high as 50%. The incidence depends on the types of

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insects active in the area, the existence and types of inter-planted crops, the wind, the blossom structure, and the blossom timing of the varieties involved. The prescribed isolation distance for minimum seed certification standards of genetic purity in tomato is 50m and 25m for foundation and certified seed respectively for open pollinated seed. In the earlier studies on isolation in potato leaved forms tomato, which is often a self pollinated crop, there was no out crossing beyond 33m and 40-50m safe isolation was recommended for open pollinated seed production (Veeraraghavathatham *et al.,* 12). Some tomato varieties have exerted stigma which means that the stigma is positioned outside of the anther cone and it is more susceptible to foreign pollen. In hybrid seed production of tomato exerted stigma types with seedling markers are used to avoid emasculation in crossing. Similar reports of advantages of exerted style for tomato hybrid seed production were also reported (Atanassova, 5; Kilchieilchevsky and Dodrodkin, 8). However, in exerted stigma types used as seed parent for hybrid seed production, slightly higher level of cross pollination is expected due to exposure of stigma for insect or bee pollination. Under natural conditions, cross pollination up to 5.56% has been reported (Veeraraghavathatham *et. al.,* 12) and the pollinating insects are bees (Quiros and Marcias, 10). Growing different tomato varieties in the vicinity would enhance the chance of contamination. The prescribed minimum seed certification standards for open pollinated seed production of tomato, in general, is 50m and 25m isolation distance for foundation and certified seeds production, respectively (Tunwar and Singh, 11). Also, if a high proportion of natural crossing occurs in exerted stigma types of tomato, it necessitates is lation between tomato varieties for maintenance of genetic purity. However, the isolation distance varie with the many factors such as crop, breeding behaviour, season, adjacent crops grown, natural pollina rs, wind breaks, barriers and geographical location of seed plot, etc., Further, there are no systematic stu res on the isolation distance required for maintaining genetic purity of exerted stigma types of tomato unde Indian conditions.

Hence, objective of the present study was to determine the extent of genetic contamination in exerted stigma to ato under natural crossing and to standardize the minimum isolation distance required for maintaining gen tic purity in seed production of exerted stigma (recessive) tomato under open field conditions.

MATERIALS AND METHODS

Field experiments were conducted at Punjab Agricultural University, Ludhiana in the *Rabi* season of 2006, 2007 and 2008 to facilitate natural out crossing between exerted stigma seed parent (stigma exertion above anther cone of 2mm) with recessive potato leaved seedling marker and normal inserted stigma pollen parent cv. Castle Rock with dominant cut leaved seedling marker. Adequate precautionary measures were taken to ensure that only the exerted stigma type and the contaminator parent cv. Castle Rock were allowed for natural crossing and no other tomato varieties were grown adjacent until 200 m isolation from seed parent so as to avoid any other cross pollination from other varieties. The exerted stigma seed parent with recessive potato leaved seedling marker was sown at different isolation distances 25m, 50m, 75m, 100m, 150m, 200m and 250m distance away from normal stigma (inserted) contaminator cv. Castle Rock having dominant cut leaf seedling marker. The plot size of seed parent and pollen parent was 25 m^2 each. There were no border rows surrounding the seed parent. The spacing adopted between row to row and plant to plant was 120 cm 30 cm. The crop was sown in a randomised block design with four replications per treatment. These maximum distances covered in the present study are even more than the prescribed isolation distance of 100m

for certified seed production of hybrid seeds. It was ensured that there were no physical barriers upto 250 m to facilitate natural outcrossing. The tomato seed crop was raised using the recommended package of practices. The adjacent crops near the experimental plot were onion and wheat during all the years. The flowering in male parent was early by five days compared to seed parent. Continuous flowering occurred during the months of March-April in all the years. Observations were recorded for per cent fruitset on natural crossing. The weather data pertaining to the months of flowering in the months of March and April of all three years have been presented (Table 1) which could also contribute to natural crossing.

The naturally crossed fruits of tomato were collected at various isolation distances from 25m, 50m,75m ,100m, 150m, 200m and 250m from the contaminant plot of Castle Rock and seeds were extracted and evaluated for genetic purity by conducting grow-out tests (GOT) in nursery in 2008, 2009 and 2010. The presence of seedling markers facilitate easy identification of crossed and selfed seeds in each progeny after each season following standard procedures (Agarwal, 3) of 100 plants per replication and four replications in each treatment were maintained in grow out tests.

The seeds were extracted from naturally crossed fruits in various isolation distances and sown to determine the extent of genetic contamination in the progenies. The extent of genetic contamination by natural crossing in seed crop was recorded based on the number of seedlings with cut leaf marker in the progeny which were contaminated seeds and expressed as genetic contamination percentage. The remaining seedlings with potato leaf marker were selfed.

Statistical analysis of data was done using Analysis of variance (ANOVA) for various isolation distances after data were subjected to angular transformation.

RESULTS AND DISCUSSION

The pooled data of three crops from the years 2006 to 20l0 on per cent fruit set and frequency of contaminants, extent of genetic contamination in the progeny of seed crop (exerted stigma type with potato leaf seedling marker) at various isolation distances from the contaminator, Castle Rock (normal inserted stigma with cut leaf seedling marker) are given in Table 2 and Table 3, respectively.

The pooled data of effect of isolation distances on per cent fruit set in exerted stigma tomato types due to natural crossing indicated that there existed significant differences due to isolation distances. The per cent fruit set was highest at shortest isolation distances from pollen parent compared to longest isolation distances. The highest per cent fruit set was highest at shortest isolation distance. The highest per cent fruit set was recorded at 25m isolation from pollen parent of 37.32% followed by 50m isolation (34.46%). The lowest per cent fruit set was recorded at 250m isolation of 21.58%. The highest per cent fruit set at 25m could be attributed to higher natural outcrossing at shortest isolation distance from seed parent.

Results indicated that the genetic contamination in the progeny of seed crop (exerted stigma type with potato leaf seedling marker) decreased with increasing isolation distance from the contaminator. Based on pooled data of three years, highest percentage of genetic contamination/ outcrossing of 9.26% occurred at an isolation of 25m from the pollen parent and decreased continuously at 6.64, 3.23 and 2.56% at larger isolation distances of 50, 75 and l00m, respectively. The lowest genetic contamination of 2.56% was recorded at the highest isolation distance of l00m isolation distance although it is not under the

Table 1: Weather data during flowering contributing to natural cross pollination in exserted stigma tomato.

Year	Months	Temp max (°C)	Temp min (°C)	RH morning (%)	RH evening (%)	SSH (hrs)	Rainfall (mm)	wind speed (km/hr)
2006	Mar	27.0	13.1	90	44	8.8	32.5	4.3
	Apr	36.0	18.2	56	17	9.8	5.1	5.2
	Mean	31.5	15.65	73	30.5	9.3	18.8	4.75
2007	Mar	26.1	12.4	91	44	9.1	41.3	5.5
	Apr	36.9	19.4	66	23	10.8	26.2	4.7
	Mean	31.5	15.9	78.5	33.5	9.95	33.75	5.1
2008	Mar	30.4	14.0	90	39	9.1	0.0	2.5
	Apr	34.1	17.7	68	28	10.2	50.2	5.6
	Mean	32.25	15.85	79	33.5	9.65	25.1	4.05
	Grand Mean	33.55	15.8	76.83	32.50	9.63	25.88	4.63

Table 2: Effect of isolation distances on per cent fruit set in exerted stigma tomato types due to natural crossing.

Isolation distance	Per cent fruit set			
	2006-07	2007 -08	2008-09	Pooled mean
25 m	31.18	42.56	38.22	37.32
50 m	30.86	35.98	36.54	34.46
75 m	25.98	25.63	31.20	27.60
100 m	21.35	24.60	19.85	21.93
150 m	25.98	19.45	20.65	22.03
200 m	31.56	22.34	23.67	25.86
250m	19.87	24.30	20.58	21.58
C.D. (P=0.05)	8.54	9.21	8.72	

Table 3: Effect of isolation distances on frequency of contaminants and percentage of genetic contamination in hybrid seed production of tomato (using exerted stigma seed parent).

Isolation distance (m)	April 2008			March 2009			March 2010			Pooled data		
	No of plants with potato leaf type	No of plants with cut leaf type	Genetic contamination (%)	No of plants with potato leaf type	No of plants with cut leaf type	Genetic contamination (%)	No of plants with potato leaf type	No of plants with cut leaf type	Genetic contamination (%)	No of plants with potato leaf type	No of plants with cut leaf type	Genetic contamination (%)
25	123	11	8.2	115	12	10.43	120	11	9.16	119.33	11.33	9.26
50	99	6	5.7	110	8	7.27	115	8	6.95	108	7.33	6.64
75	125	3	2.3	100	4	4.00	118	4	3.38	114.33	3.66	3.23
100	103	1	0.96	110	3	2.72	110	4	3.63	107.66	2.66	2.56
150	101	0	0	100	0	0	100	0	0	100.33	0.00	0.00
200	130	0	0	120	0	0	100	0	0	116.66	0.00	0.00
250	78	0	0	100	0	0	120	0	0	99.33	0.00	0.00
C.D. (P=0.05)			0.87			0.81			0.75			0.80

prescribed maximum permissible limit of genetic contamination. There was completely no genetic contamination at isolation distance of and beyond 150m.

Statistical analysis of percentage of genetic contamination revealed that there were significant differences among the various isolation distances studied for the extent of genetic contamination in the three years. The present study revealed that as the isolation distance increased from 25m to l00m, per cent contamination in the progeny of seeds crop (exerted stigma type with potato leaf seedling marker) decreased. The minimum genetic purity standards for Foundation and Certified seeds are 99 and 98 per cent, respectively. Self-pollinated vegetable seed crops exhibit lesser degree of variation as compared to cross-pollinated vegetables. However, genetic contamination even in self pollinated vegetables like tomato affects in such a way that any specific character bred into a variety is likely to be lost because of genetic contamination (Arya, 4).

In the present study, significant differences existed between the different isolation distances studied as the level of contamination is well above the permissible minimum seed certification standard, it is risky to reduce the prescribed isolation distance of certified seeds to l00m in exerted stigma potato leaved tomato forms for hybrid seed production. The higher levels of genetic contamination until 100m isolation could be attributed to a relative abundance of natural pollinators on long exerted stigma tomato types under the conditions of Punjab. The occurrence of natural pollinators i.e., honey bee species, *Apis mellifera* were observed in morning hours (7-10 am). The natural crossing would have been oured due to t e foraging bees on exerted stigma from the adjacent crops near the experimental plot of onion d wheat during all the years. Also the mean maximum temperature of 33.5°C, maximum sunshine hours of 9.63 and wind speed of 4.63 km/hour would have favoured anther dehiscence and pollen dispersal by bees in the location. The present findings of genetic contamination until l00m isolation distance are in contrast to Veeraraghavathalam *et. al.* (12) who reported that the safe isolation distance in potato leaved tomato was 40-50m at Coimbatore, Tamil Nadu conditions. There was zero genetic contamination at the highest isolation distance of 150 m.

The prescribed isolation distance for certified seed production of tomato for open pollinated and hybrid seeds is 25 and 100 m, respectively. However, the prescribed isolation distance would drastically affect the genetic purity in exerted stigma tomato under conditions of Punjab Agricultural University, Ludhiana. Hence,the minimum isolation distance required to be maintained for tomato open pollinated seed and hybrid seed production using exerted stigma Ex-3 as seed parent (without emasculation) is 150 m under Punjab Agricultural University, Ludhiana conditions.

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VEGETABLE TYPE PIGEONPEA GERMPLASM IDENTIFIED AND EXPLORED FROM VAISHALI DISTRICT OF BIHAR

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ABSTRACT: Genetic resources are the basic material for any crop improvement programme, obviously because they contain some unique traits/gene. Exploration for collection of germplasm is the quickest and simplest method for acquiring the desired one. Indian is world's biggest home of vegetarian inhabitants and legumes are main source of protein in their diet, pods are consumed fresh, or processed as vegetable either dried seed are used as *dal* or variety of preparation. A vegetable type pigeon pea of perennial nature has been identified and explored from Vaishali district of Bihar. Such promising and unique germplasm could be utilized by pigeon pea workers in their respective crop improvement programme to reinforcement food and nutritional security of country by efficient utilization.

Keywords: *Exploration, germplasm, pigeon pea, perennial, vegetable.*

India is world's largest homeland of vegetarian population and world leader in pulses production and impart to provide protein supplements. Indian pulse production has been struck in between 14 and 15 Mt since mid-nineties, resulting in poor consumption (33 g/capita/day) during 2010 (Ali and Gupta, 1). Pigeonpea (*Cajanus cajan* (L.) Millspaugh) is a leguminous shrub that can attain heights of 5 m. It is an ephemeral perennial (short lived) and is invariably cultivated as annual crop, except in backyard for vegetable purpose. The centre of its origin is the eastern part of peninsular India, including the state of Orissa, where the closest wild relatives (*Cajanus cajanifolia*) occur in tropical deciduous woodlands. The crop is known to be grown in 22 countries but it is cultivated in large areas only in a few countries (Saxena *et al.*, 5). Pigeonpea cultivars are grown for vegetable purpose, in the same way as a normal pigeonpea crop, however pods are harvested at the milking to dough stage of its development. The main stream accepted vegetable pigeon pea varieties should have long pods with large sweet seeds, which can easily be separate from the pod shell. In India, most of consumers prefer green podded pigeonpea for vegetable purpose. These usually charge a higher price than stripped ones, or pods of other colours (Saxena *et al.,* 7; and Singh *et al.,* 8).

Considerable diversity exists also in case of vegetable pigeonpea. Important growth and development traits (determinate/non-determinate), along with the nature of branching play an imperative role in determining its plant type. Few genotypes are erect and compact with narrow branching while in others the angle of branches open giving the appearance of semi-spread or spreading plants. Substantial variation is observed for plant height. In conventional germplasm these two characters have a considerable range with a strong environmental effect, depending on the planting time (Wallis *et al.*, 11; and Saxena *et al.,* 6). In vegetable type genotype of pigeonpea normal sugar levels are around 5.0%; but researchers at ICRISAT have identified varieties, such as ICP 7035, with a sugar content as high as 8.8% (Saxena *et al.,* 3; and Saxena *et al.,* 4). Pigeonpea grown for domestic use in backyards are maintained up to 3-4 years and attain a plant height of well over 3 m. The plants start flowering at the onset of short days and immature pods. However, optimum plant population of 250,000 – 325,000 plants /ha is quite good for early maturing vegetable type varieties whereas in contrast to long duration non-determinate types, which require 45,000–52,000 plants/ ha for optimum yields, since pigeonpea is known to be highly sensitive to environmental factors (Saxena *et al.*, 4). Keeping view the above facts this work was taken on priority. As Singh and Bhatt (9) explained exploration for collection of

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Fig. 1: Perennial and vegetable pigeon pea at pre-flowering stage and along with bunch of pods during first year.

germplasm is one of the best, simplest and quickest methods of enriching of gene pool of any crop commodity.

MATERIALS AND METHODS

One unique accession was identified and marked for regular visit. This germplasm was marked while author was on visit to review the progress of an ongoing research project. This unique pigeon pea was spotted and marked by me in the month of July 2010, I enquired to the farmers about the plant and other related information. He was unable to satisfy me, he simply told me, that since this is rice field, I never grown pigeon pea.

Table 1: Diversity in vegetable type pigeonpea germplasm of different regions.

Region	No. of accessions	Days to		Plant height (cm)	Seeds pod^{-1}	Pods plant^{-1}	Pod length (cm)
		flower	mature				
Eastern Africa	106	117 – 229	166 – 270	130 – 270	5.4 – 6.7	26 – 406	5 – 12
Southern Africa	17	131 – 194	163 – 260	185 – 260	5.4 – 6.1	33 – 154	5 – 11
Central Africa	4	141 – 166	215 – 232	200 – 230	5.4 – 5.6	74 – 130	7 –9
Western Africa	13	142 – 156	194 – 218	170 – 250	5.4 – 5.6	67 – 246	7 – 10
Central America	26	106 – 151	167 – 202	85 – 240	5.4 – 7.2	19 – 160	7 – 11
South America	16	132 – 158	182 – 230	100 – 285	5.4 – 6.1	27 – 420	5 – 11
South Asia	39	80 – 175	133 – 235	85 – 230	5.4 – 7.2	55 – 830	3 – 9
South-east Asia	8	134 – 201	190 – 264	140 – 210	5.4 – 5.9	24 – 119	5 – 9
Europe	2	156 – 174	222 – 237	210 – 260	5.4 – 5.8	137	9
Total	231	80 – 229	133 – 270	85 – 285	5.4 – 7.2	19 – 830	3 – 11

Source: Adopted from Saxena *et al.* (4).

Fig. 2 : Perennial and vegetable piegeon pea along with bunch of pods during subsequent year.

He told one interested thing , that due to creation of pond some cow dung is used and this pigeon pea seeds may me brought along with cow dung to this place, and get germinated before time on the bank of the pond, an at 4-5- feet elevation (Fig.1 and 2). I requested him to kindly protect this plant and have some watch and ward. I was in touch with farmer to know the growth and development and phenology of this unique plant type. Every time during our visit to the project site, I discussed with concerned farmers about the progress of the pigeon pea plant. Being legume, gifted with the unique ability of indeterminate growth habit, vegetative and reproductive growth was taken place simult-aneously after initial thrust. June germinated plants, comes in to reproductive phase in second week of November. Anthesis, first flowerings starts in the second week of November and behaves like perennial and continued to month of March next year. Data were recorded for growth and development. Since the size of pod and seed was amazing and was easy to peal with sweet in nature, encourage to further study for its suitability towards vegetable type. Accordingly, observations were taken and simultaneously data were recorded on growth and development yield attributes and pod yield.

RESULTS AND DISCUSSION

Taxonomy and classification of explored pigeonpea

The great botanist Linnaeus (1753) gave pigeonpea its first binomial nomenclature – Cytisus cajan. Van der Maesen (10) reported that the first scientific name of pigeonpea was given by Bauhin and Cherler during 1650- 1651 and they called it *Arbor trifolia indica* (Thora Paerou), which means ‘common dal’ in the Malayalam language of India. Van der Maesen (10) has written an excellent monograph on this aspect and at present the following taxonomical classification is globally accepted. Based on various morphological, cytological, chemical and hybridization data, Van der Maesen (10) merged genus *Atylosia*, the nearest wild relative of pigeon pea, with genus *Cajanus*. Consequently, genus *Cajanus* now has 32 species and pigeon pea (*Cajanus cajan*) is the lone cultivated species of the Cajaninae sub-tribe.

Order: Fabales

Tribe: Phaseoleae

Sub-tribe: Cajaninae

Family: Leguminosae

Genus: *Cajanus*

Species: *cajan*

Fig. 3: Seeds of vegetable pigeonpea—ready to be use as vegetable purpose.

In situ performance of explored pigeonpea

Regular watch and wards and upkeeps were taken place to provide congenial environment to prove its potential. Being ephemeral perennial shrub commonly cultivated as annual crop for human and livestock consumption. The crop phenology is basically governed by photo-period, because flowering in this species is induced by long periods of darkness. This phenomenon (photo-period sensitive reaction) has been found to be positively linked to its time to flower and biomass production. The genotype is true to type of perennial as it was evident by days to anthesis/ flowering which was 151days; similarly maturity was recorded (222 days). Generally, traditional pigeonpea cultivars and most landraces are of medium (160 -180 days) to long (>250 days) maturity durations (Saxena *et al.,* 4). It was notices by Wallis *et al.* (12) that early maturing pigeonpea genotypes are relatively less sensitive and the long duration types are most sensitive to photoperiod response. Plant height was recorded (140 cm), when after the first flush is over. Yield attributes like seeds per pod, pod per plant and pod length were recorded within the range, being a genetic characters and not much influenced with the environmental conditions prevailed (Table 2).

Table 2: Year wise performance of perennial pigeonpea.

Years	Days to		Plant height (cm)	Seeds/ pod	Pods/ plant	Pod length (cm)
	flower	mature				
First Year	151	222	140	5.4	137	8.2
Subsequent years	-	-	330	5.2	145	7.9
Average			285	5.3	141	8.1

Table 3: Classification of pigeon pea genotypes.

Point of difference	Determinate types	Indeterminate types
Photo-period sensitivity	Sensitive	Insensitive
Biomass production	produce more biomass	produce compatibly less biomass
Adopted to cropping system	Intercrop or as perennial hedges	Sole cropping
Flowers / podding pattern	flowers / pods in clusters at the top of the canopy	terminal buds are vegetative and the flowers/ pods are borne in axillary clusters
Growth pattern	Plant growth ceases after the induction of flowering and pod maturity is more or less uniform, i.e. synchronize growth habit prevailed	After some time vegetative and reproductive phase goes on simultaneously of flowering and pod maturity is not uniform i.e. non synchronize growth habit prevailed
Stresses tolerate	Less tolerate biotic and abiotic stresses than indeterminate types	Tolerate biotic and abiotic stresses better than determinate types

Table 4: Soil and nutrient dynamics of pigeonpea site.

Value	Sand (%)	Silt (%)	Clay (%)	Soil pH	Organic carbon (%)	Bulk Density (m m^3)	Electrical Conductivity (dSm^{-1})	NO_3 (ppm)	Available Phosphorus (ppm)	Exchangeable Potassium (ppm)	Sulphur (ppm)	Zinc (ppm)
Initial	26.5	42.3	31.2	7.5	0.65	1.42	0.21	121.2	12.9	91.3	4.0	0.36
Final	25.4	42.1	32.5	7.4	0.71	1.40	0.20	151.3	14.6	103.1	4.3	0.38

Inherited capability to rejuvenate, and some approximate built in stress compensation device help the pigeonpea to conquer such stresses and encourage regeneration of vital plant parts as soon as the micro-environment becomes conducive (Wallis *et al.*, 12). General growth and development traits associated with determinate and indeterminate type of pigeonpea is summarized in the Table 3.

Soil and Nutrient Dynamics

Soil samples were taken during first visit (June, 2010) and was treated as initial soil fertility status and at the end (April, 12) to know the nutrient dynamic (Table 4) in the perennial pigeon pea field after two years (Ryan *et al.,* 2). Since pigeonpea is endowed with strong and deep root system, encourage more rhizosphere microbial activities. Considerable build-up of major fertility indicators was recorded at the end of three of cycle. Physical parameters viz., sand, silt and clay composition was not much influenced by the pigeonpea. Bulk density also did not change. However other parameters related to soil fertility got influenced. N, P, K, S and Zn was improved significantly (Table 4).

CONCLUSION

Exploration for collection of desired germplasm to strengthen the gene pool of particular crop is quickest though simplest instrument. It should be an integral part of any plant germplasm augmentation programme. Perennial pigeonpea is often having traits qualify for vegetable type apart from grain purpose, though vegetable type annual pigeonpea has been developed and are in the process of wide adaptation, under rainfed condition. This unique germplasm can be utilized in the ongoing research programme as donor for high rain fall area like Bihar and other Eastern States to strengthen vegetable protein right from podding stage.

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QUALITATIVE EFFECT OF WRAPPING AND CUSHIONING MATERIALS ON GUAVA FRUITS DURING STORAGE

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ABSTRACT : The aim of the present study was to investigate the effect of wrapping and cushioning materials on guava (*Psidium guajava* L.) fruits during storage. Fruits were packed in different wrapping and cushioning materials viz. Tissue paper, Cling wrap, Banana leaves and Teak leaves as wrapping materials, Neem leaves, Rice straw and Bamboo leaves as cushioning materials and control. All the treatments were kept at controlled room temperature (25±2°C), relative humidity (85±5%) in corrugated fibre board (CFB) boxes. The effectiveness of the treatments was assessed in terms of its impact on fruit appearance, weight loss, total soluble solids (TSS), titratable acidity, ascorbic acid contents and total sugars. It was found that wrapping of fruits with cling wrap showed better result for most of the parameters rating followed by wrapping with teak leaves. In organoleptic ratings fruits wrapped in teak leaves showed better result while poor rating was recorded in cling wraps.

Keywords: *Cushioning, guava, organoleptic, quality wrapping, storage.*

Guava (*Psidium guajava* L.) is one of the most important fruit crops of tropical and sub-tropical regions of India. It is one of the commonest fruits liked by poor and the rich people.

The whole fruit is edible along with skin. Due to high calorific value guava fruits have achieved fame as "Poor man's Apple" in India (Singh, 10). Guava tree are very hardy, long lived/ prolific bearer and need comparatively less attention which makes its cultivation more remunerative (Tyagi and Patel, 12). India has great potential to produce high quality guava fruits and to export them to other countries however its marketability is still limited to local market. This is due to the delicate nature of fruit, poor handling practices and inadequate storage facilities. Therefore, proper handling technique and control of the ripening process are crucial for the better shelf life of guava fruits. Use of proper packaging material is a vital component of post harvest management. The efficiency of different wrapping and cushioning materials varies from fruit to fruit. Therefore, selection of suitable packaging material is of prime importance for better shelf life of fruits. The present investigation was carried out on winter guava fruits to study the effect of various wrapping and cushioning materials on shelf life of guava.

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MATERIALS AND METHODS

Present studies were carried out in Post Graduate Laboratory of Department of Horticulture, Gobind Ballabh Pant University of Agriculture and Technology, Pantnagar during October and November 2010. Fully mature fruits of guava cv. Pant Prabhat at green colour were harvested. These fruits were packed in corrugated fibre board boxes (CFB). Fruits were wrapped in tissue paper, cling wrap, banana leaves and teak leaves. Cushioning was done by keeping the cushioning materials between the two rows of fruits inside the CFB boxes. Neem leaves, rice straw and bamboo leaves were used as cushioning materials (Fig. 1). Observations for all the parameters were recorded after 4^{th} and 7^{th} day of storage. Per cent loss in weight was determined by calculating difference between initials weight and weight after storage and this value is changed into percentage. TSS was recorded with the help of hand refrectometer at room temperature. Acidity and ascorbic acid were determined by titrametric methods as described by A.O.A.C. (1) and Ranganna (7). Total sugar and pectin content were

determined by method as described by Rangana (1986). TSS: acids ratio was calculated by dividing T.S.S. by acid per cent. Organoleptic rating was done by a panel of four judges taking into consideration texture, appearance and taste. The data was analysed statistically using completely randomised design (CRD) and critical difference (C.D.) was calculated at 5 per cent. The per cent data were transformed angularly whenever seemed fit.

RESULTS AND DISCUSSION

Per cent loss in weight (PLW) increased with increasing period of storage in all the treatments. Fruits wrapped in cling wrap showed minimum PLW whereas untreated fruits showed maximum PLW after seven days of storage. Likewise it was minimum when rice straw was used as cushioning material (Fig. 1). The loss in fruit weight might be due to the fact that wrapping materials are known to retard the rate of respiration, transpiration and maintaining fruit firmness. These results are in close conformity with the finding of Baviskar *et al*. (3) as they reported maximum per cent loss in fruit weight from control fruits while polythene packed fruits showed minimum loss in weight of guava fruits. Present finding revealed that the edible quality of guava fruits was decreasing with increasing storage period. Pectin retention was also higher in cling wrap after 7 days of storage when neem leaves were used as cushioning material (Fig. 2). The reduction in pectin content during storage might be due to degradation of insoluble protopectin by the enzymes such as pectin methyl esterase (PME) enzyme and activity of enzyme increased as ripening advanced in guava. These findings are in accordance with the results of Chaitanya (4) in guava as he reported minimum retention of pectin from unwrapped fruits.

There was significant effect of wrapping and cushioning on TSS (Table 1). Fruit wrapped in cling wrap showed the reduced rate of increase in TSS. This might be mainly due to slow conversion of starch into sugars. Maximum increase in TSS was observed in cushioning of fruits with Neem leaves followed by wrapping of fruits with Teak leaves. It might be due to quick conversion of starch into sugar. TSS content of guava fruits increased initially up to 4th day of storage and decreased` thereafter. Increase in total soluble solids during storage may be due to the breakdown of complex polymers into simple substances by hydrolytic enzymes which might be further metabolized during respiration and thus the level got decreased during subsequent storage. Sharma *et al.* (8) also found similar results as they reported that newspaper packed fruits of guava cv. Sardar recorded the maximum increase in TSS. Wrapping and cushioning materials had no significant effect on acidity (Table 1). Acidity of the fruits decreased continuously in storage at room temperature. Maximum acidity was found when fruits were harvested. These findings are in close conformity with Agarwal *et al.* (2) as they reported that titratable acidity decreased with advancing maturity. The decrease in acidity during storage might be due to conversion of acids into salts and sugars by the enzymes particularly invertase.

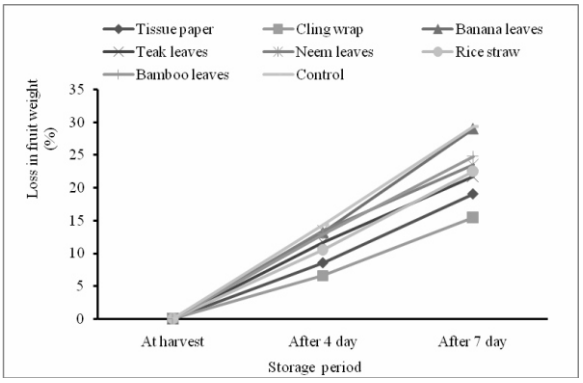

Fig. 1: Effect of wrapping and cushioning material on loss in fruit weight.

Total sugars content of guava fruit increased with high rate up to 4th day of storage and then rate was decreased thereafter (Table 2). The increase in total sugar during storage might be because of an increase in reducing sugars and non-reducing sugars resulting conversion of starch into simple

Table 1: Effect of different wrapping and cushioning materials on TSS and acidity in stored guava.

Treatment	TSS			Acidity (%)		
	At harvest	After 4 days	After 7 days	At harvest	After 4 days	After 7 days
Wrapping material						
Tissue paper	10.66	12.80	12.80	0.210 (2.521)	0.093 (1.740)	0.018 (1.870)
Cling wrap	10.20	11.16	12.20	0.180 (2.460)	0.130 (2.120)	0.114 (1.932)
Banana leaves	13.27	13.26	12.13	0.150 (2.192)	0.091 (1.720)	0.087 (1.660)
Teak leaves	10.63	12,30	13.26	0.210 (2.530)	0.125 (2.011)	0.104 (1.844)
Cushioning material						
Neem leaves	13.13	12.93	14.53	0.180 (2.454)	0.102 (1.820)	0.102 (1.820)
Rice straw	12.93	13.50	13.16	0.190 (2.563)	0.098 (1.772)	0.101 (1.832)
Bamboo leaves	12.26	14.00	13.27	0.170 (2.250)	0.117 (1.950)	0.093 (1.730)
Control	12.67	13.80	12.13	0.150 (2.233)	0.082 (1.640)	0.075 (1.550)
C.D. (P=0.05)	1.79	0.41	0.82	NS	NS	NS

Note: Values in parentheses are angularly transformed.

Table 2: Effect of different wrapping and cushioning materials on total sugar and TSS: acid ratio.

Treatment	Total Sugar			TSS/Acid ratio		
	At harvest	After 4 days	After 7 days	At harvest	After 4 days	After 7 days
Wrapping material						
Tissue paper	6.42 (14.67)	10.23 (18.56)	12.51 (20.71)	55.61	135.09	116.80
Cling wrap	6.23 (14.66)	12.27 (20.56)	12.65 (20.83)	55.32	91.32	100.78
Banana leaves	6.02 (14.21)	13.39 (21.46)	13.41 (21.48)	91.62	148.05	146.66
Teak leaves	5.90 (14.06)	12.40 (20.62)	13.40 (21.47)	54.94	110.82	117.98
Cushioning material						
Neem leaves	6.56 (14.89)	12.70 (20.88)	12.91 (21.07)	70.89	130.96	127.72
Rice straw	6.03 (14.22)	12.77 (20.94)	13.25 (21.34)	65.04	150.61	115.07
Bamboo leaves	6.17 (14.39)	12.69 (20.85)	13.70 (21.75)	80.63	120.19	131.79
Control	6.97 (15.31)	14.03 (22.00)	14.67 (22.52)	84.08	169.05	159.03
C.D. (P=0.05)	0.18	0.76	1.00	NS	NS	NS

Note: Values in parentheses are angularly transformed.

Table 3: Effect of different wrapping and cushioning materials on ascorbic acid and organoleptic rating.

Treatment	Ascorbic Acid			Organoleptic rating		
	At harvest	After 4 days	After 7 days	At harvest	After 4 days	After 7 days
Wrapping material						
Tissue paper	159.48	48.34	27.75	7.20	6.25	4.70
Cling wrap	164.88	81.05	49.83	7.13	5.84	4.20
Banana leaves	147.24	40.45	23.64	6.95	6.06	4.29
Teak leaves	168.12	45.38	29.04	7.05	6.78	4.45
Cushioning material						
Neem leaves	169.20	36.01	19.46	6.75	6.25	4.04
Rice straw	177.84	38.98	21.39	6.61	5.83	3.49
Bamboo leaves	147.29	45.88	27.15	6.92	5.80	3.67
Control	172.26	27.15	18.04	7.52	6.20	3.69
C.D.(P=0.05)	15.18	15.12	13.06	0.51	0.99	0.37

sugar and later on reduction in rate was due to utilization of sugar in the process of respiration. These results are in close conformity with the findings of Parihar and Kumar (6) as they reported that total sugars were increased with the increase of storage period in guava. TSS: acid ratio was increased in fruit during storage (Table 2). It might be due to the fact that increase in TSS was there during storage while acidity decreased (Agarwal *et al.,* 2).

Fruits wrapped in cling wrap retained higher content of ascorbic acid during storage after seven days of storage likewise when bamboo leaves used as cushioning material showed maximum retention

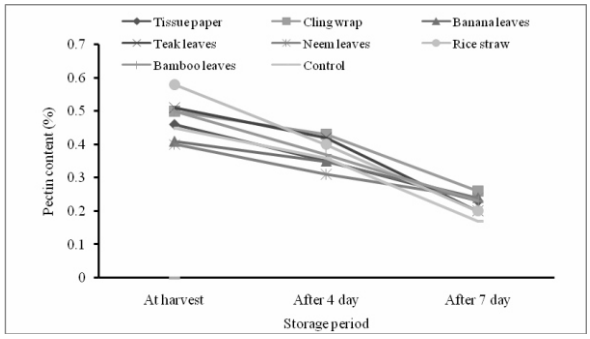

Fig. 2: Effect of wrapping and cushioning material on pectin content.

of ascorbic acid (Table 3). Cling wrap probably retard several ripening processes and hence the rate of conversion of L-ascorbic acid into dehydro ascorbic acid is slowed down. The loss in ascorbic acid content of fruit during prolonged storage is mainly due to oxidation of L-ascorbic acid into dehydro ascorbic acid by the enzyme ascorbinase. Gupta and Jawandha (5) and Srivastava *et al.* (11) also found decreasing trend of ascorbic acid during storage of peach and guava fruits, respectively. The organoleptic quality was better in wrapped fruits as compare to unwrapped control fruits except cling wrapped fruits which showed poor organoleptic rating during storage (Table 3). Similar results were also recorded by Siddiqui and Gupta (9) as they reported that the organoleptic quality was better in wrapped guava fruits as compare to unwrapped control fruits except polythene wrapped fruits which showed poor organoleptic rating throughout the storage.

On the basis of above results, it can be concluded that for most of parameters cling wrap showed good results closely followed by Teak leaf wrapping. Fruits wrapped in banana leaves showed growth of fungus in some fruits. Effect of different cushioning materials on physical and chemical parameters are satisfactory up to some extent.

Fruits without wrapping and cushioning (control) had poor physical and chemical properties. In organoleptic ratings fruits wrapped in Teak leaves showed best results while poor rating was recorded in Cling wrapping.

In overall cling wrap was considered as a good wrapping material for guava fruits followed by wrapping with Teak leaves. Among the naturally available materials Teak leaves showed best results.

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EFFECT OF VARIOUS MULCH MATERIALS AND SPACING ON GROWTH, YIELD AND QUALITY OF STRAWBERRY

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ABSTRACT: An experiment was conducted at the Horticultural Research Farm of Babasaheb Bhimrao Ambedkar University, Lucknow. The experiment was performed to find out the most suitable mulching material and an ideal spacing for strawberry cultivation under Lucknow conditions. The experiment was laid out in a Factorial Randomized Block Design with three replications. The treatments comprised of six mulching materials viz. paddy straw, dry grass (*Saccharum* spp.), dry leaves (dry neem leaves), red polyethylene, green polyethylene and transparent polyethylene) with two spacings (30 x 15 cm and 30 x 30 cm). On the basis of the statistical data, it is concluded that spacing of 30 x 30 cm with green polyethylene mulch was found to be the best in terms of plant growth viz. plant height, spread of plants, number of leaves and leaf area. Similarly, spacing of 30 x 15 cm with green polyethylene mulch significantly influenced number of flowers, fruit length and fruit width, yield and quality. However, there was slight difference in quality parameters among different treatments.

Keywords: *Strawberry, mulching materials, spacing, growth, fruit quality.*

Strawberry (*Fragaria x ananassa* Duch.) is one of the most fascinating fruit of the world being rich source of vitamins, minerals and tantalizing flavour and aroma. Though, it is minor fruit of temperate regions, due to the advent of day neutral cultivars, it can be grown profitably even in tropical and subtropical regions (Ram *et al.*, 7). Recently, strawberry has become the favourite fruit crop among the growers, especially near towns and cities. Because of its remunerative prices; the area under this crop is increasing rapidly (Singh and Asrey, 9). It is amongst the ten fruit crops, which give quicker and very high returns per unit area on the capital interests, as a crop ready for harvesting within six months of planting (Sharma and Sharma 12). However, presently farmers grow strawberry without maintaining proper planting space. Consequent upon this, high percentage of under sized, unmarketable fruit and incidence of pest and diseases have been noticed which is a bottleneck for obtaining good returns. Higher plant population per unit area has generally tended to increase the fruit yield upto 27% in strawberry. There are meager attempts on morphological, phenological and yield attributes under different spacings. Further, strawberry is one of the crop among the other crops that response drastically to the increase of soil temperature/ light reflectance produced with the use of mulches. Gutal *et al.* (5) observed that the use of plastic mulches in agriculture helped to increase the production per unit area for all types of crops as polyethylene mulch films increase soil temperature 5-7 °C facilitating faster germination and better root proliferation, in addition to checking weed growth, preserving the soil structure, retaining soil moisture and increasing CO_2 contents around the plants. Considering these facts, the systematic studies were conducted to standardize the appropriate mulch material and spacing for quality and higher yield of strawberry fruits under Lucknow conditions.

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MATERIALS AND METHODS

Field experiment was conducted during 2008-2009 at the Horticultural Research Farm of the Babasaheb Bhimrao Ambedkar University, Lucknow in a Factorial Randomized Block Design with three replications. Treatment combinations consisting of six mulching materials viz. paddy straw, dry grass (*Saccharum* spp.), dry leaves (dry neem leaves), red polyethylene, green polyethylene and transparent polyethylene) and two spacings i.e. 30 x 15 cm and 30 x 30 cm. Healthy and

disease-free runners of Chandler strawberry were procured from Dr. Y. S. Parmar University of Agriculture and Forestry, Solan, H. P. in the month of October, 2008. Before planting they were planted in shade house for proper acclimatization after which they transplanted in well-prepared beds under open field conditions. Transplanting was done at the last week of October. Red polyethylene sheet, green polyethylene sheet and transparent polyethylene sheet were used and spread over the beds. Corresponding to the position of plant, incisions were given on mulch and the plant stems were taken out through the slits to keep the foliage uncovered. Paddy straw, dry grass and dry leaves were spread over the plots evenly in different treatments to maintain a mulch thickness of about 10 cm. All the necessary cultural practices and plant protection measures were followed uniformly for all the plots and treatments during the experimentation period. Observations were recorded on the height of plant (cm), spread of plants (cm), number of leaves (cm), number of flowers per plant, fruit length (cm), fruit breadth (cm), fruit weight (g), yield per plant (g). Total Soluble Solids (°Brix) of the berry was determined with the help of Hand Refractometer. The titrable acidity (%) and ascorbic acid (mg/100g) were determined as per standard procedures of Ranganna (8).

RESULTS AND DISCUSSION

On the basis of the observations and data recorded it was found that the vegetative growth, yield attributes and quality parameters were significantly affected by mulching and spacings, respectively. Data clearly revealed that the maximum vegetative growth viz. plant height, spread of plants (east-west and north-south), number of leaves and leaf area were observed in green polyethylene mulch followed by red and transparent polyethylene mulch with the wider spacing of 30 x 30 cm over the other treatments (Table 1). The better response in plant growth parameters might be because of suitable conditions found under the green polyethylene mulch which is the combination of the properties of clear and black mulches. With clear mulch, all wave lengths of radiation (light) are transmitted through the mulch. The long wave lengths (infra-red radiation) are converted to heat under the clear film and provide the greatest amount of soil warming. However, photosynthetic active radiation (PAR) is also transmitted and responsible for the vigorous weed growth under clear mulch. Although, black mulch blocks PAR, weeds do not grow underneath. Therefore, it simultaneously generated almost as much heat as clear mulch and suppressed weeds like black mulch. The plants grown under the higher densities produced fewer crowns and leaves as reported by Wright and Sandrang, 18. The present results are in conformity of the finding of (Tarara, 15). However, 30 x 30 cm (plant to plant spacing) provided better space for the root distribution. It also indicated a shift in the most favourable environment in root growth consists of optimal moisture availability. This lead to increase root activities which might have been resulted in better nutrient uptake, subsequently better dry matter formation and gas exchange. These results are also supported by Goulart and Funt (4) and Sharma and Yamdagni (10).

Data presented in Table 2 clearly indicated the influence of various treatments and reflected that the maximum number of flowers were observed in green polyethylene with 30 x 15 cm. This might be because the green polyethylene with 30 x 15 cm spacing creates a better microclimate and made the field weed free. Whereas, the red and transparent polyethylene mulch were not success in controlling the weed population in the field that resulted in absorbing the most of the PAR by the weeds (Johnson and Fennimore, 6). And also it might be because closer spacing provided enough competition to reduce vigorous vegetative growth (Wright and Sandrang, 18). They also stated that the medium density produced the greatest number of flowers per inflorescence. Uselis (17) reported that wider spacing reduced the total number of inflorescences as observed in the present investigation. Slight enhancement in increased fruit

Table 1: Effect of mulching and spacing and their interaction on plant growth and flowers of strawberry cv. Chandler.

Treatments	Plant height (cm)		Plant spred E-W (cm)		Plant spread N-S (cm)		No. of leaves per plant		Leaf area (cm^2)	
Spacing / Mulching	S_1	S_2	S_1	S_2	S_1	S2	S_1	S_2	S_1	S_2
M_1	9.01	10.49	14.31	18.23	14.89	18.91	6.66	83.55	30.58	53.24
M_2	7.76	10.12	12.52	17.63	13.09	18.32	6.10	7.86	28.59	38.27
M_3	7.13	9.28	11.70	17.45	12.29	18.64	5.46	7.61	18.24	36.43
M_4	10.68	12.46	15.28	20.87	16.23	20.82	6.93	10.76	26.80	62.43
M_5	11.23	14.94	17.35	23.75	17.82	24.32	6.93	12.37	38.20	62.89
M_6	10.47	11.49	14.36	18.56	16.14	19.53	6.89	10.03	21.32	58.81
CD (P=0.05)										
Mulching	0.86		0.94		0.98		0.75		2.37	
Spacing	0.49		0.54		0.57		0.43		1.37	
Interaction	1.21		1.33		1.39		1.06		3.36	

Where, M_1 = Paddy straw; M_2 = Dry grass, M_3 = Dry leaves; M_4 = Red polyethylene; M_5 = Green polyethylene, and M_6 = Transparent polyethylene; S_1 = 30 15 cm and S_2 = 30 30 cm.

Table 2: Effect of mulching and spacing and their interaction on flowers, fruit growth and yield of strawberry.

Treatments	No. of flowers per plant		Fruit length (cm)		Fruit breadth (cm)		Fruit weight (g)		Yield/plant (g)	
Spacing / Mulching	S_1	S_2	S_1	S_2	S_1	S2	S_1	S_2	S_1	S_2
M_1	16.29	15.20	3.96	4.43	2.99	3.73	10.31	10.55	137.84	123.75
M_2	16.02	15.16	3.94	4.21	2.90	3.57	9.67	10.34	121.55	102.88
M_3	15.34	14.56	3.79	4.03	2.44	3.56	8.00	9.83	93.76	97.61
M_4	18.18	17.75	4.62	4.71	3.92	4.11	11.23	11.25	161.60	148.61
M_5	19.52	18.69	4.67	5.10	3.92	4.68	12.18	12.65	188.18	165.71
M_6	18.88	18.00	4.47	4.70	3.82	4.10	11.89	12.07	168.24	157.03
CD (P=0.05)										
Mulching	1.35		0.38		0.15		0.78		9.28	
Spacing	0.78		0.21		0.08		0.45		6.35	
Interaction	1.90		0.52		0.21		1.11		13.10	

Where, M_1 = Paddy straw; M_2 = Dry grass; M_3 = Dry leaves; M_4 = Red polyethylene; M_5 = Green polyethylene and M_6 = Transparent polyethylene; S_1 = 30 x 15 cm and S_2 = 30 x 30 cm.

Table 3: Effect of mulching and spacing and their interaction on fruit quality parameters of strawberry cv. Chandler.

Treatments	TSS (°Brix)		Acidity (%)		Ascorbic acid (mg/100g)	
Spacing / Mulching	S_1	S_2	S1	S_2	S_1	S_2
M_1	9.83	9.78	0.70	0.71	64.44	55.12
M_2	8.96	9.67	0.73	0.71	59.81	49.81
M_3	8.70	9.18	0.72	0.72	59.31	52.20
M_4	10.42	10.45	0.69	0.65	63.89	71.93
M_5	9.88	10.02	0.70	0.61	78.46	77.89
M_6	11.23	11.48	0.61	0.61	64.11	76.47
C.D.(P = 0.05)						
Mulching	0.17		0.04		0.14	
Spacing	0.10		0.02		0.09	
Interaction	0.25		0.05		0.19	

Where, M_1 =Paddy straw; M_2 =Dry grass; M_3 =Dry leaves; M_4 = Red polyethylene; M_5 = Green polyethylene and, M_6 = Transparent polyethylene; S_1 = 30 15 cm and S_2 = 30 30 cm.

length, fruit width, fruit weight and yield was found in green polyethylene. Same trend of fruit size (length and width) and weight was significantly reflected in wider spacing (30 x 30 cm). However, closer spacing also revealed good performance. Perhaps it was because of the spacing system. Wider spacing get sufficient light and nutrients which resulted to increase the size and weight. Although, the closer spacing accommodate more number of plants than wider spacing results in overlapping of leaves (shelf shading) to their adjacent plants and intermingled of roots that increased competition for the available resources (water, light and nutrients). Ahmad (1) stated that more space available for uptake of all the nutrients to the fruits where they acted as sink for storing the nutrient and finally translocated to fruits which are the source of sink. These absorbed nutrients might have been utilized by the fruits as a result of which there was increase in size and weight of fruit. Badiyala and Joolka (4) have also observed that wider spacing have better sized fruits. On the contrast, Ram *et al.* (7) registered that the fruit size (fruit length and width) was increased as spacing decreased. Similar result for fruit weight was obtained by Ahmad (1). Fruit yield significantly higher at 30 x 15 cm plant to plant spacing without much affecting fruit quality. Similar results on increased yield with closer spacing have also been reported by Ram *et al.* (7) and Sharma (11).

It is obvious from the data (Table 3) that fruit quality was significantly affected by mulching and spacings. Better fruit quality viz., TSS (°Brix), acidity (%) and ascorbic acid (mg/100g) of strawberry were found in green polyethylene mulch which was at par with transparent polyethylene mulch. This might be because of increase in temperature underneath the green polyethylene mulch. The result was supported by Singh et al. (13) and Tang *et al.* (14). Spacing wise quality attributes like TSS (°Brix), acidity (%) and ascorbic acid (mg/100g) were found to be in 30 x 30 cm enhanced with little or negligible difference in the spacing of 30 x 15 cm (plant to plant). The result was in consonance with Tripathi *et al.* (16) who reported that the TSS (°Brix), acidity (%) and ascorbic acid (mg/100g) were found higher in wider spacing of 40 x 70 cm. It was possible that more light exposure and greater accumulation of photosynthates might have contributed to an increase in vitamin C (ascorbic acid) content in berry. Awasthi and Badiyala (2) reported that TSS and total sugars were significantly higher in wider spacing than closer spacing.

Among all the mulch materials, polyethylene performed better than the organic mulches i. e. straw mulch, grass mulch and leaf mulch. This might be due the fast evaporation from the organic mulches, less suppression of weeds and low temperature under organic mulches. Similar result was also supported by Tang *et al.* (14).

From the above discussion it is therefore, suggested that the green polyethylene mulch with the spacing 30 x 15 cm (plant to plant) suitable for high yield without affecting the fruit quality under the Lucknow conditions.

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STUDIES ON SEED VIGOUR DETERIORATION IN PEA (*Pisum sativum* L.)

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ABSTRACT: Seed vigour evaluation was conducted on ten pea accessions to study their level of deterioration at varying temperature and time durations. The accessions were subjected to different temperature (30°C and 45°C) and storage durations (48 hours and 72 hours) during accelerated ageing. Observations were recorded for seed vigour in terms of germination percentage, germination index, vigour index I, vigour index II and electrolyte leakage. Germination percentage and vigor index was greatly affected after subjecting to large durations of time at high temperature. The higher temperature (45°C) after 72 hours induced more electrolyte leakage from the some accessions. The results revealed that vigour level of seed deteriorates after storage at high temperature. Significant varietal differences were observed in accessions in terms of their inherent capacities to withstand higher temperature treatments both after 48 hours and 72 hours. The rate of seed deterioration was faster in some accessions as compared to other.

Keywords: *Seed treatment, correlation, accelerated ageing, vigour index, seed leakage.*

Pulses on account of their significant contribution in balancing the nutrition and health of man and animals and due to the strategic position in the biospectrum of the earth can not be overlooked. They are only the richest source of protein in agricultural crop galaxy and have been truly referred as "Unique Jewels" for Indian crop husbandry (Swaminathan, 13). The pea has an important status among plants in general and among pulses in particular due to its peculiar qualities and extensive human consumption. A large amount of quality pea seed is required for sowing to ensure successful crop establishment, but non availability of such seeds is a limiting factor in boosting India's pea production. High seed and seedling vigour is required for a good stand establishment and successful crop performance in pea. Varieties with high seedling vigour are also needed for better competitive ability against weeds. Vigorous seeds will produce excellent emergence and stand in proper soil environment. It can improve the chances for satisfactory emergence. Vigor is often implied when discussing seed quality and most growers have to use the terms and quality and vigour interchangeably. Seeds vigour comprises those properties, which determine the potential for rapid uniform emergence and development of normal seedlings under a wide range of field conditions (ASPB, 4). The rapid and synchronous germination rate as well as good field establishment will be characteristic of vigorous seeds.

The vigour levels of seeds get decreased right from the seed is produced on the mother plant. The deterioration of stored seed is a natural phenomenon and the seeds tend to loose viability and vigour even under ideal storage conditions. (Bhatti and Sato, 5). The rate of seed deterioration varies greatly from one species to another and even among varieties of the same species. The performance capabilities of many seeds deteriorate due to variations in temperature, relative humidity and moisture content in storage (Abdul-Baki, 1). An organization of cellular membranes is at its peak by the time a seed reaches physiological maturity (Abdul-Baki, 1). Seeds undergo a structural disorganization process during the drying period before harvest, the lower the water content, the greater the disorganization. The degree of cell membrane leakage in response to ageing can be measured inn terms of rate of seed electrolyte leakage (Larson, 11; Khan *et al.,* 10).

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Seed ageing is an important parameter to assess/estimate the seed vigour. Accelerated ageing is a good vigour test for various crop seeds including pea (Tyagi, 14). Seeds subjected to accelerated ageing lost vigour sooner than viability (Gorecki, 7). The accelerated ageing test is rapid, inexpensive, simple and useful for many species. It has also shown a good correlation with stand establishment in pea (Caldwell, 6). Keeping the above points in view, the present investigation was conducted to study the behaviour of various pea (*Pisum sativum* L.) varieties to varying storage periods through the technique of accelerated ageing.

MATERIALS AND METHODS

Ten genotypes/accessions of pea (*Pisum sativum* L.) were procured from the genetic stock of Division of Germplasm Collection and Evaluation, National Bureau of Plant Genetic Resources, New Delhi. The accessions so collected were raised at experimental farm of Department of Genetics and Plant Breeding, Kisan PG College Simbhaoli Panchsheel Nagar UP during 2010 to increase the number of seeds. The seeds so collected were subjected to a vigour studies in the Seed Testing Laboratory of Department of Seed Science and Technology, Ch. Charan Singh University, Meerut India during Jan.–Feb., 2010. The tests were conducted as per the recommendations of AOSA (3).

Seeds were evaluated for seed germination, vigour index I, vigour index II and electrolyte leakage before subjecting to accelerated ageing. Seeds from each accession were subjected to accelerated ageing treatment at 100% relative humidity at two different temperature (30°C and 45°C) in a controlled chamber for 48 hours and 72 hours. For germination and vigour tests following vigour tests were performed.

1. Germination Test: Germination test was conducted using between paper (BP) method of germination and twenty five seeds per replication were sown on paper towel. Germination test was conducted according to the International Seed Testing Association rules (Anonymous, 2). Seeds were placed on the surface of double sheets of paper towel which were moistened with distilled water. The seeds were covered with other sheet of paper towel. The sheets were rolled and placed vertically in a plastic beaker, covered with polythene bags and placed at 30°C temperature in a germinator. Germination data were recorded from day one (D_1) to day six (D_6). Final count was made at 6^{th} day. Germination was interpreted as the percentage of seeds producing normal seedlings (Anonymous, 2).

$$\text{Germination percentage} = \frac{\text{No of normal seedlings}}{\text{Total no of seeds planted}} \quad 100$$

2. Germination Index: To calculate the germination index, the number of normal seedlings was counted from D_1 to D_6 and the germination index was calculated for each replicate according to following formula suggested by Magurie (12).

$$\text{SGI} = \frac{\text{Number of normal seedlings}}{\text{Days of I}^{st}\text{ count}} + \ldots\ldots + \frac{\text{Number of normal seedlings}}{\text{Days of final count}}$$

The high value for this parameter denotes high speed of germination and consequently high vigour.

3. Vigour Index I and Vigour Index II: The germination percentage obtained in the germination test was used to calculate vigour index. The vigour index was calculated adopting the method of Abdul Baki (1).

Vigour Index I = Germination percentage x average seedling length

Vigour Index II = Germination percentage x Seedling dry weight

4. Electrical Conductivity Test: The seed material used for this test was first subjected to accelerated ageing at 100% relative humidity and at two temperature regimes of 30°C and 45°C.

Seventy five seeds in three replications of 25 seeds each were counted and weighed and placed in a glass flask containing 100ml of deionized water. The flasks were covered with aluminum foil to prevent contamination and were shaken intermittently. The flasks were kept at 30°C for 20 hours (Hampton and Tekrony, 8). The exudates so collected were filtered and conductivity measurements were taken using portable conductivity meter (Model LT-17). The average values obtained from each accession were expressed as μ/cm/g.

RESULTS AND DISCUSSION

The results of present investigation showed the varying reaction of different accessions to the accelerated ageing conditions.

1. Germination Percentage: The germination percentage of the accessions (Table 1) under normal conditions ranged from 60.02% (DMR-11) to 89.95% (NBP-82). Under accelerated ageing conditions the varieties behaved positively to temperature and time fluctuations. The mean germination of varieties ranged 53.2% to 88.4%. The interaction between accessions and temperature was significant. The accessions such as EC-342007 and DMR-7 lost the germination of seeds faster than NBP-82, NBP-72 and EC-501259 under both temperature and time durations. A reduction of only 1% was recorded in accession NBP-82. The results showed that varietal differences in germination percentage were present in pea accessions. The results also showed that the rate of deterioration varies with the accessions and some of the accessions showed faster deterioration as compared to others. It can be thus concluded that knowledge is thus important for predicting storage conditions. Iqbal and Smith (9) reported the similar results while studying the accelerated ageing in pea.

2. Germination Index: The accessions exhibited different responses to germination index. The temperature and time durations during ageing process had a positive effect on germination index. Under normal conditions, the mean value of germination index varied from 8.46 to 15.06 (Table 1). The accession number IC-208375 had the highest value (15.06) and lowest value was recorded in IC-424895.

The interaction between accessions and temperature was found significant. The accession IC-208375 again showed a lowest reduction in germination index as compared to other accessions, such as NBP-60 that recorded a highest reduction at both temperatures of 30°C and 45°C (as 8.24 and 8.10). The accession DMR-7, NBP-611 and DMR-11 showed a large decline in germination index under both time durations. The interaction between accessions and time durations was least visible in NBP-82, IC-208375 and IC-424815. NBP-82 showed a slight decrease in germination index in accordance with high germination percentage. The germination index was higher in the varieties exhibiting greater germination percentage.

3. Vigour Index I and Vigour Index II: Different temperature and storage conditions significantly affected vigour index I and vigour index II.NBP-82 exhibited vigor index I and EC-342007 possessed lowest vigour index I. Under the normal conditions IC-208375 possessed highest values of vigour index II and IC-424895 showed lowest values of vigour index II. This variation in vigour index could be attributed to varietal differences.

The interaction of accessions with varying temperature and time durations was significant (Table 2). NBP-82 possessed highest vigour index I and vigour index II at 30°C, while as EC-342007 exhibited lowest vigor index values at the same temperature. DMR-11 was most highly affected by time durations of 72 hours at 45°C, while IC-208375 was least affected by temperature at 45°C. In general a decrease in vigour index values (vigour index I and vigour index II) was found in all accessions with increase in temperature from 30°C-45°C. Reduction in shoot length at higher temperature in pea have also reported.

Table 1: Accession means for different seed vigour parameters.

Name of Accession	Germination percentage	Germination index	Vigour index I	Vigour index II	Electrical conductivity (µ/g)
EC-342007	68.58	9.83	558.79	2276.96	23.43
DMR-11	60.02	9.49	658.61	3014.38	13.63
IC-424895	80.58	8.46	967.21	1491.01	28.20
EC-501259	83.16	14.26	745.35	3174.52	9.43
DMR-7	77.0	9.80	779.53	3031.16	22.10
IC-208375	88.0	15.06	2458.64	4643.29	6.63
NBP-72	80.50	10.11	1436.01	3263.36	16.06
NBP-61	70.83	12.60	2248.83	3725.61	16.90
NBP-82	89.75	14.3	2833.23	4193.96	5.43
NBP-60	85.08	11.27	1577.51	1902.86	19.23

Table 2: Accession means for different seed vigour parameters as affected by accelerated ageing treatments.

Name of Accession	Storage duration (hours)	Germination percentage		Germination index		Vigour index I		Vigour index II		Electrical conductivity (µ/g)	
		30°C	45°C	30°C	45°C	30°C	45°C	30°C	45°C	30°C	45°C
EC-342007	48	67.5	65.3	9.20	9.00	496.30	430.33	2024.90	1982.84	24.52	30.35
	72	63.3	56.5	8.43	8.44	505.30	410.80	1824.56	1776.56	26.02	36.30
DMR-11	48	59.3	57.4	8.22	8.00	633.20	612.14	2929.40	2820.44	18.00	19.24
	72	55.4	53.2	7.49	7.12	523.82	499.24	2680.00	2630.32	22.46	25.28
IC-424895	48	79.3	79.00	8.12	7.32	950.43	930.21	1472.62	1405.42	28.50	42.90
	72	78.2	77.6	7.81	7.00	942.70	908.40	1470.66	1382.49	29.23	44.22
EC-501259	48	81.2	79.4	13.98	13.23	732.21	721.23	3036.22	3006.80	10.22	11.92
	72	78.4	77.10	12.42	12.22	703.80	688.00	2921.29	2918.20	10.88	14.00
DMR-7	48	72.4	70.2	8.24	8.00	703.42	682.82	2916.25	2820.36	28.20	32.30
	72	68.3	66.8	7.33	6.54	700.00	650.40	2728.80	2634.90	27.29	38.82
IC-208375	48	86.4	84.3	15.00	14.66	2444.12	2382.90	4572.10	4458.88	6.92	7.37
	72	80.4	75.9	13.92	13.84	2377.42	2365.81	4492.16	4332.40	7.52	8.22
NBP-72	48	78.4	77.0	10.02	9.23	1410.22	1392.23	3122.80	3025.28	17.16	20.25
	72	76.3	73.2	10.00	8.80	1402.82	1352.36	3003.22	2916.19	21.40	23.94
NBP-61	48	65.4	63.8	12.40	12.36	2120.72	2022.30	3521.20	3329.92	17.49	20.20
	72	58.4	53.7	11.90	11.00	1924.80	1812.16	2822.50	2677.55	22.84	25.28
NBP-82	48	88.4	87.5	14.11	13.80	2742.70	2692.91	4052.66	4009.22	6.00	6.25
	72	85.9	80.8	12.96	10.32	2703.81	2680.06	3922.82	3836.41	6.08	6.40
NBP-60	48	80.4	80.2	10.23	9.22	1421.52	1388.46	1898.22	1830.38	20.28	22.80
	72	80.4	77.4	8.24	8.10	1416.21	1384.33	1822.30	1725.20	21.92	24.28

4. Electrolyte Leakage: Varietal means for electrolyte leakage was significantly affected by different temperature and storage durations (Table 2). Under the normal conditions NBP-82 possessed lower seed leakages and therefore high vigour, however the highest seed leakage was found in IC-424895 and was hence reported to be of lowest vigour category among accessions under study.

The interaction between electrolyte leakage and temperature was highly significant. A significant positive interaction was also reported between time durations and electrolyte leakage. NBP-82 was least affected by temperature treatments both at 30°C and 45°C and only <2% increase was found in seed exudates readings by conductivity meter. The accession DMR-7 was highest affected by higher temperature treatments both at 48 hour and 72 hour durations. An increase of >16µ/g was recorded in DMR-7 at 45°C temperature after 72 hours. In general all the accessions responded positively to the varying temperature and time period durations during accelerated ageing treatments. At 30°C temperature and 48 hours duration, highest electrolyte leakage was recorded in IC-424895, while NBP-82 possessed lowest leakage. The accession NBP-82 was again least affected at 45°C temperature after 72 hours while DMR-7 showed highest electrolyte leakage among the accessions. NBP-82 and IC-208375 maintained lowest leakage when subjected to varying temperature at 48 hours and 72 hours, depicting specific genotype potentials.

The results of this investigation revealed that the rate of seed deterioration increased with the increase in storage periods and storage temperatures. Significant differences in rate of deterioration were observed among accessions. Seeds of some accessions deteriorated faster than others under similar storage conditions. The knowledge of differences in rate of seeds deterioration in different genotypes may be very useful to predict seed vigor after long term storage. It is thus recommended that the germination test of the various genotypes should be conducted at regular intervals for the seeds that are being stored under ordinary storage conditions. Such varieties that show the highest deterioration during testing may be rejuvenated in the field to obtain fresh seed with higher vigor levels. This would certainly saver the germplasm of seed banks from abrupt deterioration and can be saved for longer time periods. In this way, it could be ensured that the germplasm material lying in the seed banks has high vigour percentage.

It is further recommended that the detailed study should be undertaken to know the probable cause of rapid seed deterioration in different varieties of the same species. The information so collected would enable us to generate such storage conditions that would have lowest limiting effect on the vigor of the seeds. In this way, the germplasm evaluation for storage life may be better understood.

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EFFECT OF FOLIAR SPRAY OF ZINC, CALCIUM AND BORON ON SPIKE PRODUCTION OF GLADIOLUS CV. EUROVISION

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ABSTRACT: The experiment was carried out on spike production in gladiolus with foliar application of zinc, calcium and boron, conducted in Horticulture Garden of Chandra Shekhar Azad University of Agriculture and Technology Kanpur in Randomized Block Design with four replications. The experimental plots were 32 with 8 treatments and two levels of each of zinc, calcium and boron treated by zinc sulphate 0.5%, calcium sulphate 0.75% and borax 0.2%, respectively. The results obtained revealed that the foliar spray of zinc at 0.5% to gladiolus plant was most effective to influence the vegetative growth and size of spike.

Keywords : *Zinc, calcium, boron, gladiolus, spike.*

Gladiolus, called as sword lily, belongs to the family Iridaceae and sub-family Irioideae. Gladiolus is a beautiful ornamental bulbous plant, grown for its bewitching and glamorous flowers. Gladiolus is grown on herbaceous border, bed, rockery, pot and also for cut flowers. It is grown in several states of India and successfully grown in plains as well as in hills. Light sandy soil with 6-7 pH and sunny weather is most congenial for its growth and development. Among micronutrients required in small amount, boron is necessary for carbohydrate transport within the plant (Gauch and Dugger, 3) and most of absorbed by the plants in undissociated boric acid (H_3BO_3). Zinc is essential for carbon dioxide evolution and utilization of carbohydrate and phosphorus metabolism and synthesis of RNA. Calcium is the chief constituent of plants as calcium pectate of middle lamella of cell wall and is therefore an important part of of plant structure. Calcium is involved in formation of cell membrane (Hewitt, 4). In our country not much work has been done on production of spike of gladiolus with foliar spray of zinc, calcium and boron. Most of the information are available based on the work carried out in the foreign countries but those recommendations can not be help full as such under our agro-climatic condition. Hence the cultural management and technique for quality flower spike production need to be developed and standardized. Keeping in view of the above facts, a field trial was conducted to investigate the effect of zinc, calcium and boron on production of spike in gladiolus.

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MATERIALS AND METHODS

The experiment was laid out at Horticulture Garden of C.S.A. University of Agriculture and Technology Kanpur, where climatic condition is semi-arid and sub-tropical with hot dry summer and cold winter. Randomized block design with four replication was selected for eight treatment combinations, two levels of each of zinc (0, 0.5%), calcium (0, 0.75%) and boron (0, 0.2%) were treated by zinc sulphate 0.5%, calcium suphate 0.75% and borax 0.2%, respectively. The planting of corms were done on Ist November 2006. First irrigation at the time of land preparation and regular irrigation was carried at an interval of 15 days. Five weedings and six hoeings during cropping period were done and earthing was done when the plant was erect at 20-22 cm height. The nitrogen, phosphorus and potash were applied at the rate of 160, 80, 80 kg/ha, respectively. Nitrogen was applied in two splits of 80 kg/ha each, first at the time of soil preparation and second at six leaves stage. FYM was also added equaly to each plot. The observations on each treatment were recorded on the growth and flowering characters.

RESULTS AND DISCUSSION

The field trial was mainly aimed to test the

effect of zinc, calcium and boron on growth, flowering and production of spike of gladiolus. Calcium is the chief constituent of plant, as calcium pectate is present in middle lamella of cell wall. It is essential for metabolism, nitrate assimilation, binding of nucleic acid with protein and is involved in the formation of cell membranes. Boron is necessary for carbohydrate transport within the plant. It is involved in cellular differentiation and development, nitrogen metabolism, fertilization, active salt absorption, harmone metabolism, water relation and photosynthesis. Zinc is involved in the synthesis of auxin and it is essential for carbon dioxide evolution and utilization of carbohydrate and phosphorus metabolism. Gladiolus being a monocotyledonous plant has no cambium in vascular bundles and the vascular bundles were scattered among the tissue unsystematically. So that no secondary growth occurs in this plant and mostly it grows without branching. Therefore, spraying of zinc, calcium and boron were sprayed separately.

The plant height was not significantly affected by spraying of calcium. The dala (Table 1) indicated that the maximum height (81.70cm) was attained with the application of zinc. The reason for increase in height of gladiolus might be due to increased synthesis of auxin and utilization of carbohydrate in improving plant height. Similar finding was also observed by Chaturvedi *et al.* (1) in gladiolus.

The length of leaf (57.73 cm) was increased significantly with the application of zinc than calcium and boron. It has been found to play a role in coagulating the auxin concentration and nitrogen metabolism, which might have increased the length of leaf in gladiolus plant. It has also been observed by Sharova *et al.* (6) and Singh and Tiwari (7). The application of zinc increased the width of leaf from 2.50 cm to 2.85 cm, which was in similar to Sharova *et al.* (6) in gladiolus and Singh and Tiwari (7) in onion.

The application of boron increased the number of leaves per plant from 7.96 to 8.44 and application of zinc from 7.66 to 8.74, though the application of calcium was not significant but in presence of zinc increased the number of leaves per plant up to 9.99. this indicated significant interaction of calcium and zinc. The findings are agreed with the finding of Chaturvedi *et al.* (1) and Singh *et al*. (8) in gladiolus. The plants treated with calcium and zinc exhibited more thickness i.e. 1.49 cm and 1.52 cm, respectively. However, boron and different interactions could not increase this parameter. This finding is supported by Makory *et al.* (5) in onion. The width of plant at bottom was significantly affected by the fertilization with calcium and zinc.

The quality of gladiolus spike is mostly recognized by its length and thickness. Length of spike is directly related to nutritional status of plant. The application of calcium and zinc increased the length of spike significantly supported by Chaturvedi *et al.* (1). The thickness of spike was observed maximum with application of zinc followed by calcium and boron. Boron was not found significant supported by Fernandes and Lima Filho (2). Rachis is flower bearing place of the spike which length was increased by boron and calcium application. Longest rachis was produced with calcium followed by boron, and zinc could not affect it significantly, which is in support of Fernandes and Filho (2). Number of florets per spike is also a parameter for judgment of quality of spike. Florets always face in one direction and as such more number of florets per spike enhance the beauty of the spike. The spray of boron and calcium had improved the number of florets per spike significantly. The width and length of floret was significantly affected by application of boron and zinc but calcium could not affect this trait. This finding is in consonance with Chaturvedi *et al.* (1).

Keeping in view the results summarized above it may be concluded that the foliar spraying of zinc at 0.5% to gladiolus plants was effective in influencing most of parameters particularly the size of spike and floret followed by calcium @ 0.75% application.

Table 1: Effect of foliar spray of zinc, calcium and boron on spike production in gladiolus.

(a) B × Ca				(b) Zn × B				(c) Ca × Zn			
Plant height (cm)											
B / Ca	**Ca_0**	**Ca_1**	**Mean**	**Zn / B**	**B_0**	**B_1**	**Mean**	**Ca / Zn**	**Zn_0**	**Zn_1**	**Mean**
B_0	80.01	80.07	80.04	Zn_0	78.88	80.92	79.90	Ca_0	79.88	81.62	80.75
B_1	81.50	81.62	81.56	Zn_1	81.20	82.19	81.70	Ca_1	79.92	81.77	80.85
Mean	80.75	80.85	80.80	Mean	80.04	81.56	80.80	Mean	79.90	81.70	80.80
Length of leaf (cm)											
B_0	56.57	56.62	56.60	Zn_0	55.58	55.72	55.65	Ca_0	55.62	57.69	56.65
B_1	56.73	56.83	56.78	Zn_1	57.61	57.85	57.73	Ca_1	55.68	57.77	56.73
Mean	56.65	56.73	56.69	Mean	56.60	56.78	56.69	Mean	55.65	57.73	56.69
Width of leaf (cm)											
B_0	2.58	2.66	2.62	Zn_0	2.45	2.54	2.50	Ca_0	2.47	2.80	2.64
B_1	2.69	2.76	2.72	Zn_1	2.79	2.90	2.85	Ca_1	2.53	2.89	2.71
Mean	2.64	2.71	2.67	Mean	2.62	2.72	2.67	Mean	2.50	2.85	2.67
Number of leaves per plant											
B_0	7.93	7.98	7.96	Zn_0	7.43	7.89	7.66	Ca_0	7.64	8.71	8.18
B_1	8.42	8.45	8.44	Zn_1	8.48	8.99	8.74	Ca_1	7.67	8.76	8.22
Mean	8.18	8.22	8.20	Mean	7.96	8.44	8.20	Mean	7.66	8.74	8.20
Thickness of plant (cm)											
B_0	1.40	1.48	1.44	Zn0	1.37	1.39	1.38	Ca_0	1.34	1.48	1.41
B_1	1.42	1.50	1.46	Zn1	1.51	1.53	1.52	Ca_1	1.43	1.56	1.49
Mean	1.41	1.49	1.45	Mean	1.44	1.46	1.45	Mean	1.38	1.52	1.45
Width of plant (cm)											
B_0	2.52	2.55	2.54	Zn_0	2.51	2.52	2.51	Ca_0	2.49	2.58	2.54
B_1	2.55	2.58	2.56	Zn_1	2.57	2.61	2.59	Ca_1	2.53	2.60	2.57
Mean	2.54	2.57	2.55	Mean	2.54	2.56	2.55	Mean	2.51	2.59	2.55
Duration of heading (days)											
B_0	68.40	66.03	67.22	Zn_0	67.76	65.07	66.17	Ca_0	68.16	68.08	68.12
B_1	67.85	62.20	65.02	Zn_1	67.17	64.97	66.07	Ca_1	64.17	64.06	64.12
Mean	68.12	64.12	66.12	**Mean**	67.71	65.02	66.12	**Mean**	66.17	66.07	66.12

Contd.....

Table 1: Contd…

(a) B × Ca				(b) Zn × B				(c) Ca × Zn			
B / Ca	Ca_0	Ca_1	Mean	Zn / B	B_0	B_1	Mean	Ca / Zn	Zn_0	Zn_1	Mean
Length of spike (cm)											
B_0	55.00	56.33	55.66	Zn_0	54.65	54.77	54.71	Ca_0	54.29	55.51	54.90
B_1	54.80	56.56	55.68	Zn_1	56.68	56.59	56.64	Ca_1	55.13	57.76	56.44
Mean	54.90	56.44	55.67	Mean	55.66	55.68	55.67	Mean	54.71	56.64	55.67
Thickness of spike (cm)											
B_0	0.71	0.75	0.73	Zn_0	0.70	0.71	0.70	Ca_0	0.68	0.75	0.72
B_1	0.72	0.77	0.75	Zn_1	0.77	0.78	0.78	Ca_1	0.72	0.80	0.76
Mean	0.72	0.76	0.74	Mean	0.73	0.75	0.74	Mean	0.70	0.78	0.74
Length of rachis (cm)											
B_0	47.35	49.84	48.59	Zn_0	48.49	50.38	49.44	Ca_0	48.18	48.45	48.32
B_1	49.28	51.72	50.50	Zn_1	48.70	50.62	49.66	Ca_1	50.69	50.87	50.78
Mean	48.32	50.78	49.55	Mean	48.59	50.50	49.55	Mean	49.44	49.66	49.55
Number of florets per spike											
B_0	15.37	18.07	16.72	Zn_0	16.60	18.19	17.39	Ca_0	19.07	16.25	16.16
B_1	16.95	19.54	18.25	Zn_1	16.84	18.31	17.57	Ca_1	18.72	18.89	18.81
Mean	16.16	18.81	17.48	Mean	16.72	18.25	17.48	Mean	17.39	17.57	17.48
Width of floret (cm)											
B_0	7.67	7.75	7.71	Zn_0	7.44	7.78	7.61	Ca_0	7.58	8.07	7.83
B_1	7.98	8.00	7.99	Zn_1	7.98	8.20	8.09	Ca_1	7.64	8.11	7.88
Mean	7.83	7.88	7.85	Mean	7.71	7.99	7.85	Mean	7.61	8.09	7.85
Length of floret (cm)											
B_0	8.52	8.68	8.60	Zn_0	8.38	8.94	8.66	Ca_0	8.63	9.04	8.83
B_1	9.15	9.21	9.18	Zn_1	8.82	9.42	9.12	Ca_1	8.69	9.20	8.95
Mean	8.83	8.95	8.90	Mean	8.60	9.18	8.90	Mean	8.66	9.12	8.90
Longevity of spike on plant (days)											
B_0	14.16	16.99	15.58	Zn_0	15.56	16.61	16.08	Ca_0	14.67	14.73	14.70
B_1	15.24	18.07	16.65	Zn_1	15.60	16.70	16.15	Ca_1	17.49	17.57	17.53
Mean	14.70	17.53	16.11	Mean	15.58	16.65	16.11	Mean	16.08	16.15	16.11

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PATH COEFFICIENT ANALYSIS FOR SEEDLING VIGOUR IN RADISH (*Raphanus sativus* L.) GENOTYPES

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ABSTRACT: The field study was conducted during 2010 and 2011 to assess the genetic variability, inter relationships and direct and indirect effects of component traits on seedling vigour in radish. High PCV values were obtained in FW (32.68%), SVI I (32.43%) and germination % (30.84%). Magnitude of heritability was highest for SVI II (92.00%) followed by germination (89.45%), 100 SW (84.90%), ASL (83.16%) and SVI I (79.27%). SVI II showed positive and highly significant association with germination %,ASL, seedling FW, DW, 100 SW and SVI I. Path analysis indicated positive direct effect of SVI I, shoot length and 100 seed weight on seedling vigour index II of different radish genotypes. The seedling vigour index I, shoot length, 100 seed weight and germination % exhibited strong positive correlation and positive or negative direct effects on seedling vigour index II emerged as important components contributing to seedling vigour. Therefore, selection primarily based on these traits may lead to identification and development of genotypes having better field emergence and seedling establishment.

Keywords: *Radish, germination, heritability, path coefficient, vigour index.*

Seed is the single most important factor in successful, uniform and high yielding crop. Good seed quality ensures high seedling vigour, better crop establishment and more biomass. Seed vigor is the cumulative impact of complex genetic and eco physiological factors on the growth and development of endosperm and embryo (Sun *et al*, 16). "Seed vigour comprises those properties which determine the potential for rapid, uniform emergence and development of normal seedlings under a wide range of field conditions" (AOSA, 2). Quicker and uniform germination facilitates superior crop yields, whereas slow and non uniform germination due to low seed vigour decreases crop yields (Basra *et al,* 3). Seed vigour determines the ability of the plants to emerge through soil and grow vigourously under varied environmental conditions (TeKrony and Egli, 17). Seedling vigour is determined by various seed and physiological parameters like seed weight or size, germination, seedling dry weight and vigour indices (Awan *et al*, 4). The factors are of immense importance in case seed vigour is used as selection criterion in crop improvement (Evans and Bhatt, 6). Information on character association responsible for seedling vigour among these traits is very limited in radish. Since, radish is a short duration, quick growing crop and depending upon cultivars and season reach marketable maturity in 30-45 days after sowing. True estimation of seedling vigour and its association with contributing characters is very important to raise quick, vigorous and uniform crop stand. Therefore, a preliminary study was conducted to estimate the genetic variability, inter relationship and direct and indirect effects of component traits on seedling vigour in radish for selection of genotypes having superior establishment under field conditions.

MATERIALS AND METHODS

The experiment was conducted at the Vegetable Research Farm, Punjab Agricultural University, Ludhiana during the winter season of 2010 and 2011. The experiment was laid out in a randomized block design replicated thrice. Planting material consisted of six genotypes of radish (*Raphanus sativus* L.) with three of them commercial cultivars (viz. Punjab Pasand, Punjab Safed and Pusa Chetki) and three advanced lines developed at PAU, Ludhiana (RL 2210, RL 9-1 and RL-25). 200 seeds of each genotype were sown on

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ridges in the first week of October each year. Between ridges and plant spacing were maintained at 45 cm and 7.5 cm, respectively. After one week of germination twenty randomly selected seedlings from each treatment were uprooted and washed carefully to remove soil particles. Data were recorded according to rules established by ISTA (8) on germination (%), seedling shoot length (cm), seedling root length (cm), seedling fresh weight (g), seedling dry weight (g), 100 seed weight (g) and seedling vigour indices I and II. The germination was calculated as per number of seedlings obtained after one week of sowing to the number of seeds sown. For determining seedling dry weight ten randomly selected normal seedlings were dried at 110°C for 17 hours and weighed. For 100 seed weight, 100 seeds were randomly selected from each genotype and weighed on electronic balance. Vigour indices were calculated using the formula given by Abdul-Baki and Anderson (1). The path analysis of direct and indirect effects for seedling vigour was calculated as suggested by Dewey and Lu (5).

RESULTS AND DISCUSSION

Mean performance of genotypes (Table 1) showed significant existence of variation for various parameters except average seed ling root length (Singh *et al.,* 15). Highest germination was recorded in Punjab Pasand (93.67%) and lowest in Punjab Safed (71.67%) after one week of sowing. Seedling shoot length (ASL) was maximum for Punjab Pasand (13 cm) followed by RL-2210(12.3 cm) which was statistically at par and was least in RL-25 (8.6 cm). ARL (seedling root length) was non significant among all the genotypes. Punjab Pasand also exhibited significantly high values for FW (fresh weight, 9.8 g), seed vigour index I (SVI 1, 1218.37), seed vigour index 2 (SVI 2, 61.16) and 100 seed weight (1.06 g). RL-22 was statistically at par with Punjab Pasand in FW, DW, vigour index 2 and 100 seed weight. RL-25 recorded lowest values for DW (0.41), seedling vigour index 1 (661.3), seedling vigour index 2 (31.55) and 100 seed weight (0.88). Variability among the characters can well be measured by the range and genotypic coefficient of variation. In most of the traits difference between phenotypic (PCV) and genotypic coefficients of variation (GCV) was not too high indicating less impact of environmental fluctuations (Rahman *et al.,* 13). High GCV and PCV values suggest that direct selection of these traits can be more beneficial. Phenotypic coefficients of variations were highest in FW (32.68%), followed by SVI I (32.43%), germination (30.84%), SVI II (27.04 %) and it was least for 100 SW (7.97%).

High magnitude of heritability was observed for all the traits except for SRL (28.87%). Heritability estimates were highest for SVI 2 (92.00%) followed by germination (89.45%), 100 SW (84.90%), SSL (83.16%), FW (80.62%) and SVI 1(79.22%), depicting that selection for these characters can be effective for improving seedling vigour in radish (Saeidi, 14). High heritability and PCV values for FW, SVI I, SVI II and final germination % show dominant effect of genes and thus bear significant effect on determining genetic variability among radish genotypes (Malik *et al.,* 11).

Seed vigour is of utmost importance in early crop establishment and growth. Correlation coefficient (Table 2) for seedling vigour index II showed significantly high and positive correlation with germination, shoot length, fresh and dry weight, 100 seed weight and vigour index I. Genotypes showing better vigour and shoot length would lead to better field performance. (Kamoshita *et al.,* 9). Further genotypic correlation coefficients were generally higher than phenotypic correlation coefficients implying strong association between two characters at genotypic level. From 100 seed weight, results also showed that bolder the seed higher the vigour index (Willenborg, 18). Germination exhibited significant and positive correlation with all the traits except root length, indicating dependence upon these traits on final seedling number (Munir *et al.,* 12). However, root length showed significantly negative correlation

Table 1: Means, range, phenotypic and genotypic coefficients (PCV and GCV) of variation, heritability and genetic advance of various seedling characters in different genotypes of radish.

Genotype	Germ. (%)	ASL (cm)	ARL (cm)	FW (g)	DW (g)	100 SW (g)	SVI I	SVI II
Punjab Pasand	93.67	13.00	5.57	9.80	0.65	1.06	1218.37	61.16
RL 9-1	73.67	9.40	5.30	6.29	0.45	0.90	694.77	33.27
Pusa Chetki	73.00	11.30	4.93	8.35	0.57	0.96	825.40	41.77
RL 2210	79.67	12.30	4.67	9.78	0.69	1.03	980.80	54.85
PP x AR	77.00	8.60	4.93	5.49	0.41	0.88	661.73	31.55
Punjab Safed	71.67	9.33	5.87	4.55	0.45	0.92	669.30	32.03
C.D.(P=0.05)	4.99	1.42	NS	1.92	0.15	3.10	117.06	11.40
Mean	78.11	10.65	5.21	7.37	0.49	0.95	841.72	42.43
Range	73.67-91.67	8.6-13	4.66-5.86	4.55-9.8	0.41-0.69	0.87-1.06	661.73-1 218.36	31.54-61. 16
PCV	30.84	17.91	11.92	32.68	25.69	7.97	32.43	27.04
GCV	29.25	16.33	6.41	29.34	19.97	7.34	28.87	25.94
h^2 %	89.45	83.16	28.87	80.62	60.42	84.90	79.22	92.00

Germination—Germ. Average Shoot Length—ASL, Average Root Length—ARL, Fresh Weight—FW, Dry Weight—DW, 100 Seed Weight—100 SW, Seed Vigour Index I—SVI I, Seed Vigour Index II—SVI II, Phenotypic coefficient of variation (PCV), Genotypic coefficient of variation (GCV), Heritability in broad sense (h^2)

Table 2: Genotypic (G) and phenotypic (P) correlations among different seedling characters in radish.

Character		Germ	ASL	ARL	FW	DW	100 SW	SVI 1	SVI II
Germ.	G	1.000	0.738**	0.261	0.710**	1.703**	0.805**	0.879**	0.908**
	P	1.000	0.662**	-0.060	0.604*	0.491	0.697**	0.941**	0.789**
ASL	G		1.000	-0.278	0.918**	0.910**	0.805**	0.829**	0.892**
	P		1.000	-0.055	0.900**	0.886**	0.795**	0.769**	0.835**
ARL	G			1.000	-0.731**	-0.708**	-0.089	-0.335	-0.010
	P			1.000	-0.152	0.005	-0.023	0.003	-0.045
FW	G				1.000	0.892**	0.915**	0.905**	0.747**
	P				1.000	0.815**	0.811**	0.849**	0.841**
DW	G					1.000	0.809**	0.879**	0.908**
	P					1.000	0.697**	0.754**	0.881**
100 SW	G						1.000	0.895**	0.924**
	P						1.000	0.867**	0.905**
SVI 1	G							1.000	0.910**
	P							1.000	0.898**

*P=0.05, **P=0.01

Germination— Germ., Average Shoot Length—ASL, Average Root Length—ARL, Fresh Weight—FW, Dry Weight—DW, 100 Seed Weight—100 SW, Seed Vigour Index I—SVI I, Seed Vigour Index II—SVI II

Table 3: Direct and indirect effects of component traits on seed vigour in radish.

Trait		Direct effect	Germ.	ASL	ARL	SFW	SDW	100 SW	SVI I	Correlation
Germ.	G	0.035		0.539	-0.001	-0.015	-0.594	-0.070	0.921	0.815**
ASL	G	0.730	0.026		0.001	-0.020	-0.753	0.095	0.812	0.891**
ARL	G	-0.003	0.009	-0.203		0.015	0.598	0.008	-0.414	-0.010
FW	G	-0.021	0.025	0.716	0.002		-0.704	-0.103	0.932	0.847**
DW	G	-0.844	0.025	0.755	0.002	-0.033		0.076	0.927	0.908**
100 SW	G	0.100	0.031	0.727	0.001	-0.020	-0.808		0.896	0.927**
SVI I	G	0.918	0.028	0.730	0.001	-0.020	-0.842	0.095		0.910**

ASL- Average shoot length, ARL- Average root length, FW- Seedling fresh weight, DW- Seedling dry weight, Germ.-Germination,SVI I-Seed vigour index I,SW-Seed weight, SVI II-Seed vigour index II.

with fresh weight and dry weight. The correlation matrix of component seedling traits showed that improving germination, seedling length, fresh weight and 100 seed weight would improve the seed vigour index and thereby better field establishment (Lafond and Baker, 10).

Correlation estimates give broader indication of interrelationship between component traits which could be misleading due to mutual cancellation of effects of component characters. But path coefficient analysis provides for partitioning of relationships into specific direct and indirect effects depicting the relative influence of each of the causal factors in determining the seedling vigour (Guler *et al.,* 7). Path coefficient analysis taking seedling vigour index II as dependent variable revealed that seedling vigour index I, shoot length and 100 seed weight exhibited strong positive direct effect with SVI II with minor positive contribution from germination %. Correlation and path analysis indicated major positive relationship and contribution of SVI I, ASL and 100 SW, thereby implying that these could be exploited for selection of genotypes with high seedling vigour (Singh *et al,* 15). DW though having significant positive correlation had significant negative direct effect on seedling vigour. FW exerted small negative direct effect but great indirect effect via DW and 100 SW on seedling vigour.

The results from the present study indicated high heritability for germination %, ASL, 100 SW FW, DW and SVI I. These characters also exhibited positive or negative direct effect on seedling vigour index II. Therefore, emphasis should be laid these component traits while selecting genotypes with high seedling vigour index for crop improvement.

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EFFECT OF POST HARVEST CALCIUM TREATMENTS ON SHELF LIFE OF GUAVA CV. SARDAR

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ABSTRACT: The search for techniques that extend shelf life of guava (*Psidium guajava*) fruits, and reduce its postharvest losses is desirable. The objective of this work was to evaluate the effects of concentrations of competitive ethylene antagonist calcium salts on conservation of 'Sardar' guava fruits. Treatments consisted of 0.5%, 1% Calcium Nitrate, 1%, 2% Calcium Chloride and 0.5%, 1% Calcium Sulphate for 12 days followed by storage at room temperature. The application of 1% calcium chloride for 12 days was efficient in delaying loss of skin color and in keeping fruit firm at room temperature storage. The calcium nitrate at 1% concentration was efficient in delaying skin colour loss only when fruits were stored at 25°C. The effect of calcium nitrate was quite significant on the reduction of acceptability in both the year. The product was efficient in delaying the ripening of fruits and the calcium chloride 1% showed the best effect.

Keywords: *Psidium guajava, calcium salts, postharvest, shelf life.*

Guava is a highly perishable fruit that shows intense metabolic activity. Guava fruit becomes fully ripe between three and five days at room temperature. Due to such perishability, the control of fruit ripening is fundamental for increasing shelf life after harvest. The main factors depreciating postharvest quality in guava are fast loss of green color, excessive softening, high rot incidence and loss of turgidity. Storage under low temperatures has been considered the most efficient method to maintain quality of most fruits due to its effects on reducing respiration rate, transpiration, ethylene production, ripening, senescence and rot development. In climacteric fruits, like most guava varieties, the reduction of temperature delays the climacteric peak and, consequently, ripening. The recent finding that calcium salts interferes with ethylene link to its binding site represents a new and powerful tool for postharvest management of climacteric fruits. It has been demonstrated that the inhibition of the ethylene action delays ripening and senescence in several species of fruits, such as custard apple, guava, papaya, peach, apple, avocado, banana, strawberry and tomato. Previous finding revealed that post-harvest treat of various calcium compounds and packaging material have enhanced their shelf life, reducedment the spoilage and improved the fruit quality by delaying the onset of senescence during storage. Keeping in view the importance on crop, a study was carried out to study the effect of these compounds on storage life of guava cv. Sardar.

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MATERIALS AND METHODS

Healthy, firm, mature and uniform sized fruits of guava cv. Sardar were procured from a Horticulture Research Centre, Pattharchata on December 2007 and December 2008. The analysis carried out at post harvest laboratory of the Department of Horticulture, College of Agriculture, G.B. Pant University of Agriculture and Technology, Pantnagar. The selected fruits were cleaned, dried and treated dip method with $Ca(NO_3)_2$ (0.5% & 1%), $CaCl_2$ (1% & 2%) and $CaSO_4$ (0.5% & 1%) and subsequently packed in newspaper and stored at room temperature (28-33°C) and 85-90% relative humidity. There were seven treatments replicated thrice in a completely randomized design (CRD). Fruit samples, each comprising of 5 fruits, were drawn from each treatment at the time of storage and subsequently after 0, 3, 6, 9 and 12 days of storage for physico-chemicals analysis. The fruits were evaluated for palatability rating by a panel of 7 judges on a score card (10 points). Reducing sugar,

nonreducing sugar and pectin were analysed by following standard procedures suggested by Ranganna (8).

RESULTS AND DISCUSSION

Data depicted in Table 1 showed that packaging material, storage period, chemicals and their interaction had significant effect on reducing sugar of fruit during both the years. Maximum reducing sugar (3.18 % and 3.55 %) was found in wrapped fruits as compared to unwrapped fruits during both the years. With respect to storage period, maximum reducing sugar (3.42%) was obtained at 6th day of storage in first year, whereas, highest (3.83 per cent) reducing sugar was found in second year at 3rd day of storage. On the other hand, minimum reducing sugar (2.91% and 3.05%) was found at 12th days of storage during both the years, respectively. Different chemicals significantly affected the reducing sugar content of fruits. Highest reducing sugar (3.21% and 3.58%) was obtained with calcium chloride (1%) and lowest (3.08% and 3.44%) was found in control during both the years, respectively. The present studies indicated that after an initial rise, the percentage of reducing sugar decreased during storage in ambient temperature. The initial increase in reducing sugars might be due to the conversion of starch into reducing sugar and later on reduction could possibly might be due to utilization of sugar in the process of respiration. The percentage of reducing sugar increased slowly during storage period upto 6th day and declined thereafter. The highest content of reducing sugar was obtained in the wrapped fruits kept in paper box. The increase in reducing sugar might be due to increased rate of starch degradation by a amylase activity (Hiwale and Singh, 7). In general, after 6th day of storage, reducing sugar decreased in all the treatments including control.

Conversion of starch and polysaccharides into simple sugar with the advancement of storage was responsible for the increase of reducing sugar and onward decline was due to the utilization of sugar in evapo-transpiration and other biochemical activities. Data presented in Table 1 showed that packaging material, storage period and chemicals and their interaction had significant effect on non-reducing sugar content of fruits during both the years. Maximum non-reducing sugar was found in wrapped fruits during both the years. In case of storage period, maximum non-reducing sugar (4.08%) was recorded at 9th day of fruit storage in first year, whereas, in second year non-reducing sugar was highest (3.66%) at 6th day of storage. Minimum non-reducing sugar (3.61 and 3.53%) was found at 12th days of storage during both the years. With respect of chemicals, highest non-reducing sugar (4.06% and 3.67%) was obtained in calcium chloride 1% while minimum non-reducing sugar was found in control during both the years. Percentage of non-reducing sugar of guava fruit increased up to 9th day of storage at room temperature. This increase in sugar in the beginning of storage is mainly due to the hydrolysis of starch. These results are in line of the results reported by Biale (2) in mango fruit during storage. Fruit treated with calcium compound as post harvest treatments retained higher percentage of non-reducing sugar during storage. High percentage of non-reducing sugar was found in wrapped fruits kept in paper boxs. The increase in the non-reducing sugar might be due to the hydrolysis of starch and conversion in the pectin substances from water insoluble to water soluble fractions. These results are in accordance with the findings of Chahal and Bal (3), Chundawat *et al.* (5), Hiwale and Singh (7) and Singh *et al.* (11).

It is evident from the data presented in Table 2 that packaging material, storage period and chemicals had significant effect on pectin content of the fruits in both the years of the investigation. In first year, maximum pectin content was obtained in wrapped fruits and minimum pectin content was found in unwrapped fruits. Similar trend was observed in second year. Storage period also had pronounced effect on pectin content of the fruits. It was found maximum at the day of harvest (zero day) and minimum at 12th day of storage. Similar pattern was obtained during second year. Pectin

Table1: Effect of post harvest treatments on the reducing sugar (%) and non-reducing sugar (%) in guava fruits cv. Sardar.

Treatments	Reducing sugar (%)			Non reducing sugar (%)		
	2007	2008	Pooled	2007	2008	Pooled
Packing (W)						
Unwrapping	3.15	3.47	3.31	3.82	3.63	3.73
Wrapping	3.18	3.55	3.37	3.99	3.65	3.82
C.D. (P=0.05)	0.03	0.033	0.032	0.057	0.051	0.054
Storage days (D)						
0 days	3.11	3.67	3.39	3.92	3.55	3.74
3 days	3.28	3.83	3.56	3.83	3.66	3.75
6 days	3.42	3.62	3.52	4.07	3.80	3.94
9 days	3.13	3.38	3.26	4.08	3.66	3.87
12 days	2.91	3.05	2.98	3.61	3.53	3.57
C.D. (P=0.05)	0.047	0.052	0.050	0.090	0.081	0.086
Chemical (T)						
$Ca(NO_3)_2$ 0.5%	3.18	3.49	3.34	3.99	3.64	3.82
$Ca(NO_3)_2$ 1.0%	3.2	3.53	3.37	4.05	3.66	3.86
$CaCl_2$ 1.0%	3.21	3.58	3.40	4.05	3.67	3.86
$CaCl_2$ 2.0%	3.18	3.53	3.36	4.02	3.65	3.84
$CaSO_4$ 0.5%	3.17	3.5	3.34	4.00	3.64	3.82
$CaSO_4$ 1.0%	3.17	3.5	3.34	3.97	3.63	3.80
Control	3.08	3.44	3.26	3.25	3.59	3.42
C.D. (P=0.05)	0.055	0.062	0.059	0.106	0.096	0.101

Table 2: Effect of post harvest treatments on the pectin (%) and fruit texture in guava cv. Sardar.

Treatments	Pectin (%)			Texture		
	2007	2008	Pooled	2007	2008	Pooled
Packing (W)						
Unwrapping	1.20	1.22	1.21	7.44	7.46	7.45
Wrapping	1.22	1.23	1.22	7.80	7.94	7.87
C.D. (p=0.05)	0.013	0.012	0.013	0 .107	0.076	0.076
Storage days (D)						
0 days	1.31	1.32	1.31	8.41	8.44	8.43
3 days	1.27	1.29	1.28	8.09	8.21	8.15
6 days	1.23	1.24	1.24	7.67	7.65	7.66
9 days	1.15	1.18	1.17	7.14	7.59	7.37
12days	1.09	1.09	1.09	6.76	6.75	6.76
C.D. (P=0.05)	0.020	0.019	0.020	0.170	0.121	0.146
Chemical (T)						
$Ca(NO_3)_2$ 0.5%	1.23	1.24	1.23	7.71	7.58	7.64
$Ca(NO_3)_2$ 1.0%	1.23	1.25	1.24	7.87	8.18	8.02
$CaCl_2$ 1.0%	1.25	1.27	1.26	8.18	8.26	8.22
$CaCl_2$ 2.0%	1.21	1.23	1.22	7.80	7.65	7.72
$CaSO_4$ 0.5%	1.20	1.23	1.21	7.39	7.62	7.51
$CaSO_4$ 1.0%	1.19	1.19	1.19	7.28	7.46	7.37
Control	1.19	1.17	1.18	7.10	7.14	7.12
C.D. (P=0.05)	0.024	0.022	0.023	0.201	0.143	0.172

content was significantly affected by different chemicals during both the years. Maximum pectin content was found in calcium chloride 1% and minimum pectin content was found with control during both the years. A significant decrease in pectin content was observed with the advancement of storage period during both the years. Maximum pectin percentage was observed in calcium chloride (1%) followed by calcium nitrate (1%). Fruit firmness is closely related with the pectin content of the fruit. Pectin content of the guava fruit decreased progressively during storage. The reduction in pectin content during storage might be due to degradation of insoluble protopectin by the enzymes. These finding are in line with findings of Bhattacharya and Ghosh (1) in banana and Seipp (9) in apple fruits. Calcium chloride (1%) maintain the fruit firmness by retarding breakdown of pectin during storage, hence the level was higher under these treatments. Higher retention of pectin following calcium chloride (1%) treatment has been reported by Singh (10) in guava fruits. Lowest pectin content was found in wrapped fruits kept in paper boxes during both the years in storage. It might be due to the softness occurring in fresh fruits after maturity at the peak of ripening which is generally associated with fairly narrowing down of firmness. Pectin methyl esterase (PME) enzyme activity increased as ripening advanced in guava. These findings are in accordance with the results of Chaitanya (4) in guava. Data presented in Table 2 showed that packaging material, storage period, chemicals and their interaction had significant effect on the texture of fruits during both the years. Minimum texture change was obtained in wrapped fruits during both the years. With respect of storage periods, minimum texture change was observed at day of harvest and maximum texture change was obtained at 12^{th} day of storage. Different chemicals had significant effect on fruit texture. Lowest texture change was found in calcium chloride 1% during both the years. Minimum texture change during storage was found with wrapped fruits kept in paper box in both the years. The reduction in moisture in fruits causing shrinkage, dullness in skin and loss of turgidity observed in control fruits. On the other hand wrapped fruits kept in paper box maintained turgidity, glossiness and smooth skin of fruits. These results are in corroboration with the Dhoot *et al.* (6) in guava.

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EFFECT OF NITROGEN AND PHOSPHORUS WITH NITROGEN SOURCES ON VEGETATIVE ATTRIBUTES OF TUBEROSE

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ABSTRACT: An experiment was laid out during two consecutive years in Horticulture garden of C. S. Azad University of Agri. and Tech., Kanpur. There were three nitrogen sources viz. Urea, Ammonium Sulphate, Calcium Ammonium Nitrate; four levels of each of nitrogen (0, 50,100 and 150kg/ha) and phosphorus (0,100,200 and 300 kg/ha), with a total of forty treatments. The results showed that there were no significant differences observed due to nitrogen sources in respect of sprouting of bulbs. Increasing doses of phosphorus caused relatively early sprouting during both the years of study. Phosphorus applied @ 200kg/ha expressed tallest plant during both the years of study. Number of leaves per plant improved under ammonium sulphate followed by calcium ammonium nitrate. Phosphorus @ 200kg/ha produced maximum number of leaves during both years. Application of 150kg N/ha or 200 kg phosphorus expressed highest leaf area followed by 100 kg N/ha.

Keywords: *Tuberose, nitrogen, phosphorus, leaf size, leaf area.*

Tuberose (*Polianthes tuberosa* Linn.), a native of Maxico, belongs to the family Amaryllidaceae. It is cultivated on large scale in France, Italy, South Africa, and North Carolina, U.S.A. and many tropical and sub-tropical areas including India. The chief centers of its production in India are Maharashtra, West Bengal, Tamil Nadu and Karnataka. It is, however, well adopted to North Indian climatic conditions yet its grow well in Uttar Pradesh. The tuberose occupies very selective and special position among the ornamental bulbous plants to flower loving people because of its prettiness elegance and pleasantly sweet fragrance. It has great economic potential for cut flower trade and essential oil industries.

MATERIALS AND METHODS

The present investigations entitled "Effect of nitrogenous and phosphorus fertilizers with nitrogen sources on vegetative attributes of tuberose (*Polianthes tuberosa* Linn.)" were conducted under the eco-edaphic conditions prevailing at Horticulture Garden of Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (U.P.), India during the two consicutive years-1998-99 and 1999-2000. Uniform and healthy bulbs of tuberose cv. Double having 2.5-3.0 cm diameter were procured from N.B.R.I. Lucknow. In order to assess to exact nature and composition of soil, samples up to 20 cm depth were collected and analyzed in the Department of Agriculture Chemistry and Soil Science for physio-chemical components. The experimental field was given a preplanting irrigation and at the proper field conditions, it was prepared by giving two cross-ploughings. The clods crushed with the help of disc harrow and soil was finally levelled and brought to a good tilth with removing the stubbles, weeds etc. The required dose of Nitrogen 50,100,150 kg/ha, and phosphorus 100,200,300 kg/ha as per treatments were applied. K_2O @ 200 kg/ha and F.Y.M @ 40 tonnes/ha were applied as recommendation. The sources of nitrogen were Urea, Ammonium Sulphate and Calcium Ammonium Nitrate. Phosphorus and potash were applied in form of single superphosphate and muriate of potash, respectively. Full dose of phosphorus and potash with half dose of nitrogen were applied as basal dressing and remaining half dose of N was applied as split doses at 60 and 90 days after planting. All the

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recommended cultural and plant protection measures were applied. The experiments were laid out by following Factorial Randomized Block Design in both consecutive years of experimentation with three replications. Thus, 120 plots (1.0x1.0m size) were used for 40 treatment combinations. Experiments were analyzed through computer as suggested by Panse and Sukhatme (7). Days to sprouting was observed by keeping a constant watch in different treatments during both the years of experimentation and indicted in the number of days. Plant height was measured with help of meter scale and number of leaves was counted in sampled plants. Leaf area (cm^2) was measured by taking length and width of longest leaf from the base and multiplying by adjustment factor 0.62 as suggested by Barbieri *et al.* (1).

RESULTS AND DISCUSSION

Effect on days to sprouting of tuberose bulbs

Sprouting of tuberose bulbs as influenced by different factors viz. N sources, and level of N and P was observed after planting of bulbs during both the years of study. The mean values presented in Table 1 clearly revealed that sources of N fertilization failed to exert significant variation on the days required for sprouting of tuberose bulbs under both years trials. Application of 150kg N/ha hastened the sprouting of bulbs significantly during first year but in the second year it was non-significant requiring 9.16 and 9.50 days respectively against 9.95 and 9.88 days under control. Among the three doses of N, 50kg treatment delayed the sprouting (10.47 and 9.77 days) markedly during both years.

Increasing dose of P enhanced in earlier sprouting of bulbs during both the years. Phosphorus application @ 300kg/ha took minimum period i.e. 9.66 and 9.37 days against maximum noted under its control (10.67 and 10.14 days). All P levels caused significantly earlier sprouting when compared with control barring 100kg dose during the second year of investigation.

Interaction between phosphorous and source of nitrogen was found non significant, only numerical variations on the sprouting of tuberose bulbs were seen. Application of 300 kg/ha interacting with CAN caused considerably earliest (9.63 and 9.30 days) sprouting when compared with P_0S_1 (urea without P) which took maximum duration (11.0 and 10.37 days) in this regard during both the years of study. The minimum 9.50 and 9.34 days required for sprouting for P_3N_3 against maximum period required by P_0N_1 (11.20 and 10.42 days).The interaction of S × N did not affect this parameter significantly. However, sprouting was hastened by S_3N_3 (9.30 and 9.41 days) numerically during both the years of study confirming to the reports of Mukhopadhyay *et al.* (5). Other interaction effect i.e. P×S and P× N were also found non-significant during both years of investigation. The interaction among P×S×N did not bring significant difference in this regard. Treated plants showed early sprouting when compared with control in the first year but the trend was contradictory during second year of study.

Effect on height of tuberose plant

It is evident from mean values (Table 2) that application of ammonium sulphate, remaining at par with calcium ammonium nitrate, proved more effective in increasing the plant height than urea during both years. In this way urea proved relatively less effective for increasing height of plant. Ammonoum sulphate produced 46.39 and 48.25 cm tall plants followed by CAN (45.92 and 47.79 cm) and urea (45.1 and 45.79 cm).

Among the dose of nitrogen nutrition, the highest one i.e. 150 kg excelled the rest of dose causing 47.14 and 48.82 cm height followed by 100 kg (45.96 and 47.19 cm) and 50 kg (44.31 and 45.81) during corresponding years of study. Application of phosphorus also caused significant alterations and P_2 (200kg/ha) proved significantly more superior than rest of dose barring 100 kg and 300 kg/ha (P_1 and P_3) during second year of study. The plants under P controls remained dwarf under

Table 1: Effect of nitrogenous and phosphorus fertilizers on the days to sprouting of bulb in tuberose cv. 'Double'.

1998-1999

P	P S			P N			Treated vs. control		Mean
	S_1	S_2	S_3	N_1	N_2	N_3	Treated	Control (N_0)	
P_0	11.00	10.49	10.52	11.20	10.86	9.96	10.67	10.66	10.67
P_1	10.18	9.96	10.19	10.43	10.31	9.60	10.11	10.10	10.11
P_2	9.93	9.84	9.85	10.18	10.06	9.38	9.87	9.80	9.87
P_3	9.77	9.78	9.63	10.06	9.54	9.50	9.70	9.24	9.66
Mean	10.20	10.02	10.05	10.47	10.19	9.16	10.09	9.95	
N_1	10.22	10.25	10.71						
N_2	10.29	10.14	10.14						
N_3	10.10	9.44	9.30		S	N	P	P S	P N	S N	T vs Cont.
S N				C.D. (P=0.05)	NS	0.46	0.53	NS	NS	NS	NS

1999-2000

P	P S			P N			Treated vs. control		Mean
	S_1	S_2	S_3	N_1	N_2	N_3	Treated	Control (N_0)	
P_0	10.37	10.20	9.81	10.42	10.26	9.69	10.13	10.32	10.14
P_1	9.36	9.70	9.90	9.77	9.67	9.52	9.65	10.30	9.72
P_2	9.30	9.56	9.60	9.53	9.50	9.43	9.49	9.60	9.50
P_3	9.34	9.50	9.30	9.36	9.44	9.34	9.38	9.32	9.37
Mean	9.59	9.74	9.65	9.77	9.22	9.50	9.66	9.88	
N_1	9.59	10.98	9.65						
N_2	9.58	9.67	9.91						
N_3	9.61	9.48	9.41		S	N	P	P S	P N	S N	T vs Cont.
S N				C.D. (P=0.05)	NS	NS	0.43	NS	NS	NS	NS

Table 2: Effect of nitrogenous and phosphorus fertilizers on the plant height (cm) in tuberose cv. 'Double'.

1998-1999

P	P S			P N			Treated vs. control		Mean
	S_1	S_2	S_3	N_1	N_2	N_3	Treated	Control (N_0)	
P_0	43.23	45.06	44.48	42.59	44.46	45.71	44.25	37.83	43.6
P_1	45.08	46.70	45.90	44.40	46.17	47.12	45.90	42.26	45.5
P_2	46.91	48.35	47.48	46.16	47.76	48.83	47.58	43.71	47.1
P_3	45.17	45.33	45.84	44.09	45.46	46.90	45.48	43.28	45.2
Mean	45.10	46.39	45.92	44.31	45.96	47.14	45.00	41.77	
N_1	43.29	44.97	44.66						
N_2	45.24	46.45	46.19						
N_3	46.76	47.74	46.92		S	N	P	P S	P N	S N	T vs Cont.
S N				C.D. (P=0.05)	0.97	0.97	1.12	NS	NS	NS	1.26

1999-2000

P	P S			P N			Treated vs. control		Mean
	S_1	S_2	S_3	N_1	N_2	N_3	Treated	Control (N_0)	
P_0	44.99	47.05	46.21	44.43	46.43	47.39	46.08	39.21	45.4
P_1	45.78	48.59	47.85	46.12	47.29	48.80	47.40	43.70	47.0
P_2	46.42	49.57	49.50	46.80	48.21	50.47	48.49	44.19	48.0
P_3	45.98	47.79	47.59	45.90	46.84	48.63	47.12	46.80	47.0
Mean	45.79	48.25	47.79	45.81	47.19	48.82	47.28	43.48	
N_1	44.42	46.71	46.32						
N_2	45.42	48.17	47.96						
N_3	47.51	49.87	49.09		S	N	P	P S	P N	S N	T vs Cont.
S N				C.D. (P=0.05)	1.40	1.40	1.62	NS	NS	NS	1.81

Table 3: Effect of nitrogenous and phosphorus fertilizers on the number of leaves per plant in tuberose cv. 'Double'.

1998-1999

P	P S			P N			Treated vs. control		Mean
	S_1	S_2	S_3	N_1	N_2	N_3	Treated	Control (N_0)	
P_0	36.96	39.58	38.08	35.71	38.50	40.42	38.21	27.68	37.19
P_1	38.66	41.36	40.73	38.48	40.51	41.76	40.25	35.24	39.71
P_2	39.94	41.79	41.07	39.74	40.89	42.18	40.94	37.50	40.50
P_3	39.44	41.29	40.67	39.33	40.69	41.18	40.46	36.33	40.0
Mean	38.75	41.00	40.14	38.36	40.15	41.39	39.96	34.18	
N_1	37.39	39.36	38.33						
N_2	38.74	41.15	40.56						
N_3	40.13	42.50	41.53		S	N	P	P S P N S N	T vs Cont.
S N				C.D. (P=0.05)	1.23	1.23	1.42	NS NS NS	1.59

1999-2000

P	P S			P N			Treated vs. control		Mean
	S_1	S_2	S_3	N_1	N_2	N_3	Treated	Control (N_0)	
P_0	38.45	39.46	39.01	36.02	38.94	41.97	38.98	39.33	38.0
P_1	40.17	42.44	41.22	38.68	41.28	43.87	41.28	36.66	40.8
P_2	41.29	42.60	42.10	40.63	41.96	43.40	42.00	38.93	41.69
P_3	40.60	41.80	40.66	39.94	40.84	42.27	41.03	38.13	40.73
Mean	40.13	41.58	40.75	38.82	40.76	42.88	40.82	35.76	
N_1	38.05	39.55	38.91						
N_2	40.44	41.39	40.44						
N_3	41.94	43.79	42.90		S	N	P	P S P N S N	T vs Cont.
S N				C.D. (P=0.05)	0.97	0.97	1.13	NS NS NS	1.26

Table 4: Effect of nitrogenous and phosphorus fertilizers on the leaf area (cm^2) in tuberose cv. 'Double'.

1998-1999

P	P S			P N			Treated vs. control		Mean
	S_1	S_2	S_3	N_1	N_2	N_3	Treated	Control (N_0)	
P_0	46.24	48.00	48.81	44.50	47.83	51.63	47.98	36.12	46.80
P_1	48.44	50.72	50.85	47.20	49.67	53.14	50.00	42.53	49.26
P_2	50.28	52.88	52.60	49.34	51.90	54.51	51.92	46.42	51.37
P_3	50.90	52.44	52.11	48.92	52.14	54.38	51.81	45.32	51.16
Mean	48.96	51.23	51.09	47.49	50.38	53.42	50.43	42.59	
N_1	46.32	47.78	48.37						
N_2	49.01	51.06	51.08						
N_3	51.56	54.86	53.83		S	N	P	P S P N S N	T vs Cont.
S N				C.D. (P=0.05)	0.96	0.96	1.10	NS NS NS	1.24

1999-2000

P	P S			P N			Treated vs. control		Mean
	S_1	S_2	S_3	N_1	N_2	N_3	Treated	Control (N_0)	
P_0	47.02	50.04	49.30	45.66	49.11	51.60	48.79	38.24	47.73
P_1	49.36	52.42	52.54	48.15	51.75	54.41	51.44	42.24	50.62
P_2	51.67	54.65	53.71	50.67	53.71	55.64	53.34	47.11	52.72
P_3	51.98	53.61	52.76	50.24	52.84	55.26	52.78	44.27	51/93
Mean	50.01	52.68	52.08	48.68	51.85	54.23	51.59	43.21	
N_1	47.32	40.77	48.95						
N_2	50.39	52.61	52.55						
N_3	52.31	55.65	54.73		S	N	P	P S P N S N	T vs Cont.
S N				C.D. (P=0.05)	0.99	0.99	1.14	NS NS NS	1.28

both years conditions. The results are in conformity with El-Khateep *et al.* (2) and Nair *et al.* (6).

The first order interaction i.e. P × S, P × N and S × N remaining non significant during both years of study increased the height of tuberose plants numerically under P_2S_2 (48.35, 49.57 cm), $P_2 N_3$ (48.83, 50.47 cm) and $S_2 N_3$ (47.74, 49.87 cm), respectively. Among the second order interactions $P_2S_2N_3$ maximized the height of tuberose plants but the differences remained non significant during both the years of study. Treated vs. control plants showed significant variations on the height of tuberose plants during both the years of study and treated ones attained the height of 45.00 and 47.28 cm, whereas, the control plants expressed 41.77 and 43.48 cm height.

Effect on number of leaves per plant

Ammonium sulphate proved significantly superior (Table 3) than other nitrogen sources i.e. urea and CAN during both the years of investigation (41.0 and 41.58 leaves during first and second year, respectively) barring CAN during second year of investigation where it was observed to be statistically at par with ammonium sulphate. However, urea observed to be less effective regarding 38.75 and 40.13 leaves per plant. Application of 150 kg/ha proved more effective (41.39 and 42.88 leaves) and produced significantly greater number of leaves followed by 100 kg and 50 kg/ha (40.15, 38.36 and 40.76, 38.82 leaves, respectively).

Interactions between P×S, P×N and S×N improved the number of leaves per plant numerically during both the years of trial recording 41.79, 42.60, 42.18, 43.40 and 42.50, 43.79 leaves per plant under $P_2 S_2$, P_2N_3 and $S_2 N_3$ treatments during first and second year of investigation, respectively. The second order interaction failed to exert significant influence on the leaf count during both years. The comparison of treated plants with control revealed significant variation in increasing the number of leaves per plant in the former (39.96 and 40.82) during both the years.

Effect on the leaf area

Increasing dose of nitrogen induced significantly greater leaf area (Table 4). Application of 150 kg N/ha expressed 53.42 and 54.23 cm^2 leaf area followed by 100 kg N/ha revealing 50.38 and 51.85 cm^2 area under both the year of study, respectively. Application of phosphorus through super phosphate @200 kg/ha induced significantly highest leaf area compared with its control as well as 100 kg dose during both the years. Application of 200 kg/ha when compared with 300 kg/ha level showed statistically similar leaf area under both the year's trials. The highest values were however, recorded to be 51.37 and 52.72 cm^2 under 200 kg/ha dose against the lowest 46.80 cm^2 and 47.73 cm^2 noted under control.

The interactive effect of P ×S, P×N and S×N remaining non significant improved the leaf area further expressing maximum values under P_2 S_2 (52.88, 54.65 cm^2), $P_2 N_3$ (54.51, 55.64 cm^2) and S_2 N_3 (54.86, 55.65 cm^2) during the corresponding years of study. The second order interactions did not bring significant variations in this regard during both the years of experimentation. Treated plants when compared with control revealed significant increase in leaf area in tuberose expressing 50.43, 51.59 and 42.59,43.21 cm^2 values during first and second year of investigation, respectively. The present findings are in agreement with the reports of Fernadez et al. (3) and EI-Khateep *et al.* (2) in gladiolus Mukhopadhyay *et al.* (5) and Nair *et al.* (6) in tuberose and Sang (9) in dahlia who noted significant improvement in the growth parameters of bulbous ornamentals. But Hober (4) and Preeti-Hatibarua *et al.* (8) found calcium ammonium nitrate to be more effective in chrysanthemum and gladiolus, respectively.

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CORRELATION COEFFICIENT STUDIES IN ASHWAGANDHA (*Withania somnifera* Dunal) cv. JAWAHAR-20

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ABSTARCT: In an experiment conducted on ashwagandha (*Withania somnifera* Dunal), to study the response of different organic amendments with organic manure (FYM) and bio-fertilizers in relation to plant growth, root yield and quality parameters. It was found that the seedlings (5-7 leaf stage) inoculated with *Azospirillum* @ 10^5 or 10^6 CFU resulted a significant increase in plant growth and biomass yield which exhibited a positive association among them in contributing the root yield and quality traits. The maximum and positive correlation (0.884) was observed between the total alkaloid and withanaloid content followed by fresh root weight per plant (g) and fresh root yield per ha (0.831) and between plant height and number of leaves per plant (0.777). The association of the plant height also exhibited a highly significant correlation with stem diameter (0.659), alkaloid (0.777) and withanaloid (0.668) content in the roots. The number of leaves per plant had highly significant and positive correlation (1.99) with plant canopy followed by alkaloid (0.755) and withanaloid (0.774) contents. The fresh root weight per plant exerted the positive and significant effect of high magnitude (0.831) and fresh root yield (kg) per plot. Dry root weight per plant could established a significant and positive association (0.514) with dry root yield (kg) per ha. The total alkaloid content in the roots witnessed a highly significant and positive correlation with plant height (0.777), number of leaves per plant (0.755) followed by positive and significant association with stem diameter (0.573), number of berries per plant (0.554) and fresh root yield (kg) per plot (0.485). Withanaloid content (%) witnessed a highly significant and positive correlation with plant height (0.668), number of leaves per plant (0.754) and alkaloid content (0.884). Whereas a significant and positive correlation exhibited with stem diameter (0.581).

Keywords: *Withania, correlation, root yield, alkaloid and withanaloid.*

Ashwagandha is a perennial shrub and grows naturally under subtropical dry climate in well drained, sandy loam or light red soils having ph of 7.5 to 8.0 with an average rainfall of 600-750 mm. It is been grown on large scale in dry part of the country as a medicinal plant, especially on marginal lands in several districts of Madhya Pradesh, covering an area of more than 4000 hectares (Nigam, 4) and its cultivation has extended in recent years, to Kota in Rajasthan, foot-hills of Punjab and Himachal Pradesh and Tarai regions of Uttarakhand and Uttar Pradesh. Commercial cultivation, being on priority for high returns needs a sustained and agronomic package for production of economically safe raw material for pharmaceutical industry on large scale. Owing to the increased demand for organic and safe products of ashwagandha roots, leaves and seeds used in formulation of various *Ayurvedic* and *Unani* medicines, there is prudent need to cultivate this crop by safe application of bio-organic nutrition from vermi-compost and FYM along with a beneficial free-living soil bacteria usually applied as plant growth promoting *Rhizobacteria* or PGPR in the formulation as strains of *Azospirillum*, which lives in close association of plant roots and enhance plant growth by its ability to fix atmospheric nitrogen, production of indole acetic acid, siderophore, nitrate and single molecules resulting in an increased mineral uptake in the plant roots as suggested by Bashan and Holguin (1).

Therefore, the development of a reliable tool to establish an association resulting through a symbiotic association as beneficial biological model between them and dependent plant growth

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characters on root and root quality traits in future agricultural production as studied by Misra *et al*. (3). Therefore, the present experiment was conducted to see and evaluate a response of bio-organic nutrition through a application of FYM, Vermi-compost and *Azospirillum* in Ashwagandha (*Withania somnifera* Dunal.) and an association of plant growth, seed, root yield and quality parameters was worked out to establish a relationship as a response and feasibility of safe and bio-organic application in cultivation of this medicinal plant for commerce.

MATERIALS AND METHODS

The present experiment was carried out at the experimental fields of Ch. Shivnath Singh Shandilya P.G. College, Machhra, Meerut (U.P) during the two consecutive years viz. 2005-06 and 2006-07 on perennial crop of Ashwagandha (*Withania somnifera*) cv. Jawahar-20 under the field conditions using of FYM (Farm Yard Manure), Vermi-compost and *Azospirillum.* The experiment was laid out in the factorial RBD replicated thrice. Bio-organic nutrition was applied to beds in experimental field in combinations, comprising of FYM, viz. 0 kg/plot (F_0), 2 kg/plot (F_1) or 3 kg/plot (F_3) and Vermi-compost 0 kg/plot (V_0), 2 kg/plot (V_1) or 3 kg/plot (V_2) and *Azospirillum* 0 CFU/plot (AZ_0). The chemical analysis was done in the laboratory of Medicinal and Plants under Council of Scientific and Industrial Research (CSIR), New Delhi. The average data for I year, II year were pooled and analyzed for ANOVA and interactions among the treatments as per the methods suggested by Panse and Sukhatme (5). Further, genotypic association of all the yield contributing characters with root yield and quality was worked out as path coefficient analysis suggested by Dewey and Lu (2).

RESULTS AND DISCUSSION

The correlations existed between the plant growth, root yield and quality components (Table 1) were analysed to study the association among them revealed that a strong association was exhibited. The maximum and positive correlation (0.884) was observed between the total alkaloid and withanaloid content followed by fresh root weight per plant (g) and fresh root yield per ha (0.831) and between plant height and number of leaves per plant (0.777). The association of the plant height also exhibited a highly significant correlation with stem diameter (0.659), alkaloid (0.777) and withanaloid (0.668) content in the roots. However, a significant value of coefficients was also recorded with number of berries per plant (0.500) and fresh root yield (kg) per plot. The stem diameter had significant and positive correlation with plant canopy (0.507), fresh root weight per plant (0.525), alkaloid (0.573) and withanaloid (0.581) content. The number of leaves per plant had highly significant and positive correlation (1.99) with plant canopy followed by alkaloid (0.755) and withanaloid (0.774) contents and significant correlation with number of berries per plant (0.549) and fresh root yield (0.593) per plot. The number of branches per plant witnessed positive and significant correlation with leaf area (0.511), dry root per plant (0.486), dry weight per plant (0.479) and fresh (0.481) and dry root yield per kg/ha (0.513). Plant canopy exhibited positive and significant correlation (0.542) with a single character, namely fresh root weight per plant where as the other coefficients among them were moderate and of low magnitude. The individual leaf area exhibited a significant and positive correlation with fresh (0.530) and dry (0.492) weight of roots per plant. Number of berries per plant witnessed positive and highly significant (0.705) correlation with fresh root yield per kg per plot followed by a significant and positive association with alkaloid content (0.554) in the roots.

The number of primary roots per plant exhibited a significant and positive association (0.580) with secondary root length per plant. The fresh root weight per plant exerted the positive and significant effect of high magnitude (0.831) and fresh root yield (kg) per plot. Dry root weight per plant could established a significant and positive association (0.514) with dry root yield (kg) per ha.

Table 1: Correlation coefficients among the plant growth, yield and quality components in ashwagandha as influenced by different bio fertilizer treatments.

S. No.	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	0.65**	0.777**	0.347	0.126	0.122	0.500*	-0.223	-0.111	0.037	0.079	0.134	0.284	0.120	0.456*	-0.053	0.153	0.331	0.427	0.777**	0.668**
2	—	0.410	0.402	0.507*	0.347	0.322	0.178	-0.045	0.110	0.271	0.267	0.525*	0.158	0.246	0.024	0.338	0.271	0.354	0.573*	0.581*
3		—	-0.007	1.99 **	-0.064	0.549*	-0.321	-0.028	-0.103	-0.142	0.070	-0.003	0.083	0.593*	-0.089	-0.171	0.243	0.231	0.755**	0.754**
4			—-	0.224	0.511*	0.169	-0.015	-0.112	0.071	`0.296	-0.159	0.486*	0.479*	-0.006	-0.048	0.481*	0.513*	0.241	0.225	0.155
5				—	0.308	-0.007	0.179	0.260	0.186	0.315	0.132	0.542*	0.174	0.183	0.142	0.462	-0.134	0.105	-0.008	0.098
6					—-	0.043	0.175	0.296	0.354	-0.090	0.228	0.530*	0.492*	0.153	0.386	0.272	0.206	0.038	0.043	0.082
7						—-	-0.308	0.046	0.237	-0.185	0.260	0.034	0.105	0.705**	-0.137	-0.058	0.332	0.193	0.554*	0.409
8							—-	0.276	-0.317	0.177	0.088	0.276	0.091	0.002	0.417	0.272	0.057	-0.145	-0.113	-0.025
9								—-	0.057	0.007	0.352	0.324	0.142	0.200	0.081	0.116	0.002	0.015	0.069	0.028
10									—-	-0.039	0.580*	0.073	0.254	0.053	0.004	0.048	0.038	0.121	-0.071	-0.266
11										—-	0.272	0.212	0.174	-0.282	-0.096	0.307	0.455	0.144	0.045	0.019
12											—	0.096	0.188	0.163	0.205	0.042	0.329	0.195	0.202	0.045
13												—-	0.349	0.254	0.110	0.831**	0.177	0.386	0.164	0.148
14													—-	0.104	0.244	0.171	0.514*	-0.301	0.008	0.015
15														—-	0.231	0.177	0.175	0.076	0.485*	0.455
16															—	0.048	0.160	-0.379	-0.256	-0.072
17																—-	0.151	0.443	0.079	0.013
18																	—-	0.139	0.277	0.265
19																		—-	0.418	0.229
20																			—-	0.884**

* = 0.470 and **= 0.639 (the values denoted by * are significant and by ** are highly significant at P = 0.05)

1. Plant height (cm)
2. Stem diameter (cm)
3. Number of leaves/plant
4. Number of branches/plant
5. Plant canopy (cm^2)
6. Leaf area (cm^2)
7. Number of berries/plant.
8. Number of seeds/berry
9. Main root length (cm)
10. Number of primary roots
11. Number of secondary root/plant
12. Secondary root length (cm)
13. Fresh root weight per plant (g)
14. Dry root weight (g)/plant
15. Fresh root yield (Kg)/plot
16. Dry root yield (Kg)/plot
17. Fresh root yield (Kg)/ha
18. Dry root yield (Kg)/ha
19. Fresh & Dry root weight ratio
20. Total Alkaloid Content (%)
21. Withanaloid content

The maximum and positive correlation (0.884) was observed between the total alkaloid and withanaloid content followed by fresh root weight per plant (g) and fresh root yield per ha (0.831) and between plant height and number of leaves per plant (0.777). The association of the plant height also exhibited a highly significant correlation with stem diameter (0.659), alkaloid (0.777) and withanaloid (0.668) content in the roots. The number of leaves per plant had highly significant and positive correlation (1.99) with plant canopy followed by alkaloid (0.755) and withanaloid (0.774) contents. The fresh root weight per plant exerted the positive and significant effect of high magnitude (0.831) and fresh root yield (kg) per plot. Dry root weight per plant could established a significant and positive association (0.514) with dry root yield (kg) per ha. The total alkaloid content in the roots witnessed a highly significant and positive correlation with plant height (0.777), number of leaves per plant (0.755) followed by positive and significant association with stem diameter (0.573), number of berries per plant (0.554) and fresh root yield (kg) per plot (0.485). Withanaloid content (%) witnessed a highly significant and positive correlation with plant height (0.668), number of leaves per plant (0.754) and alkaloid content (0.884). Whereas a significant and positive correlation exhibited with stem diameter (0.581).These findings are in close conformity with by Singh *et al*. (6).

The association between independent characters in respect to the fresh root yield, alkaloid and withanolid content co-existed in a significant and positive association except with a few of them but exhibiting a relationship of a very low magnitude. Number of seeds/berry, number of primary roots and dry root yield per plot had negative correlation (-0.025, -0.266 and -0.073 respectively) with a very low magnitude among them. However the other negative and positive correlations observed and recorded between various characters were of very low magnitude indicated that an application of bio-fertilizers *vis a vis* an increased dose has improved the fresh root yield and quality parameter in ashwagandha var. Jawhar-20 employed in the present investigation. The dry root yield and chemicals estimated witnessed strong and positive relationship among them but a negative with biomass in fresh weight of plant and spread of the plant canopy with a lower magnitude. However, a positive association with strong and significant magnitude was established for plant growth components namely; stem diameter (cm), leaf area (cm^2) and main root length per plant. These findings were in pace with those reported by Misra *et al.* (3).

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INTEGRATED RESPONSE OF INORGANIC AND BIO-FERTILIZERS ON YIELD AND YIELD ATTRIBUTES OF TURMERIC

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ABSTRACT: A field experiment was conducted to study the effect of integration of bio- and inorganic fertilizers on yield and yield attributes of turmeric during 2007-08 and 2008-09 at Udai Pratap Autonomous College, Varanasi, U.P. The experiment was laid out with thirteen treatments consisted of combination of two variety of turmeric (V_1 – Padrauna local and V_2 – NDH-18) replicated three times in a randomized block design. The results indicated that application of T_6 (NPK 180:90:90 kg per ha + *Azotobactor chrococcum* @ 2.5 kg per ha + *Pseudomonas floriscence* @ 2.5 kg per ha) significantly increased yield and all yield attributes over all treatments, whereas treatment T_9 (50% R.D. of inorganic nitrogen + 50% R.D. of inorganic phosphorus + 100% R.D. of potash + *Azotobactor chrococcum* @ 2.5 kg per ha + *Pseudomonas floriscence* @ 2.5 kg per ha + 50% nitrogen through carpet waste) was closely followed by treatment T_6. In respect of turmeric variety , NDH-18 was found superior over variety Padrauna local in all above conditions. On the basis of performance treatment T_6 and T_9 may be adopted for higher yield and sustainability.

Keywords : *Turmeric, bio-fertilizer, inorganic fertilizer, yield.*

Turmeric (*Curcuma longa* L. Syn *Curcuma domestica* Val.) is a herbaceous perennial plant belonging to the family Zingiberaceae. It is an ancient, most valuable, sacred spice of India and contains appreciable quantities of proteins (6.3%), lipids (5.1%), carbohydrates (69.4%) and fibre (2.6%). Turmeric is rich in minerals like phosphorus, calcium, iron and vitamin A. Turmeric is a horticultural root-crop that is important not only as a spice and cosmetic, but also as a medicinal plant worldwide (Hermann and Martin, 2; Osawa *et al.* 9; Nakamura *et al.* 8; Ishimine *et al.* 4; Hossain *et al.* 3). It is cultivated for its underground rhizomes which is used as spice and condiment, dye stuff and in drug and cosmetic industry. It forms an important adjuvant in Indian culinary as it tends colour and aromatic flavour to various dishes. It is mainly used as condiment, in the preparation of pickles and curries and as a colouring agent in textile, food and confectionary industries. Turmeric has lot of medicinal properties, it has long been used in India for the treatment of sprains and inflammatory conditions. The turmeric rhizome contains a variety of pigments among which '*curcumin*' is the major pigment responsible for colour and it varies from 3.5 to 9.0 per cent in different varieties. India is the largest producer, consumer and exporter of tumeric in the world. It is grown in an area of 163 thousand ha with an average production of 552.3 thousand tonnes (Kandiannan *et al.,* 5). Considering the economic importance of turmeric and environmental problems caused by chemicals application, it is important to cultivate turmeric using organic and bio-fertilizers. Different organic manures influence differently in terms of yield and quality of turmeric. Hence, it is necessary to know the best source of organic manure which could help in increasing the yield and quality. In view of this background, this study was aimed to evaluate the effect of different bio-organic manures on turmeric yield. Biofertilizers like *Azotobactor chrococcum* and *Pseudomonas floriscence* (PSB) ranks in upper category. *Azobobactor,* a non symbiotic N_2 fixing bacteria, is capable to fix atmospheric nitrogen non symbiotically, by which it can replace chemical fertilizer at too much extent. While *Pseudomonas* is phosphorus solublizing bacteria, which solublizes excess/unused phosphorus in soil and provide the

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plant in soluble/available form. We know that our plants use only 16-18% of applied phosphatic fertilizers, rest phosphetic fertilizers lost by various ways. So by using the PSB we can use maximum phosphatic fertilizers applied. Resulting this the yield and composition will also be increased. Carpet waste is also a very good source of major and minor nutrients, so this is also a very good substitute of chemical fertilizers.

MATERIALS AND METHODS

The study was undertaken at the experimental field of Deptt. of Agricultural Chemistry and Soil Science, Udai Pratap Autonomous College, Varanasi, U.P. during the year 2007-08 and 2008-09 on two variety of turmeric (V_1 – Padrauna local and V_2 – NDH-18) at spacing of 30x 22.5 cm. The investigation was carried out in thirteen treatments which consisted of T_1=Control (No application), T_2=100% inorganic Nitrogen, T_3=100% inorganic Nitrogen + 100%P, T_4=100% inorganic Nitrogen + 100%P+ *Azotobacter,* T_5=100% inorganic Nitrogen + 100% P+PSB, T_6=100% inorganic Nitrogen + 100%P + *Azotobacter* + PSB, T_7=50% inorganic Nitrogen + 50%P + *Azotobacter* + 50% N through carpet waste, T_8=50% inorganic Nitrogen + 50%P + PSB +50% N through carpet waste, T_9=50% inorganic Nitrogen + 50%P + Azotobacter + PSB + 50% N through carpet waste, T_{10}=25% inorganic N + 25%P + *Azotobacter* + PSB + 75% N through carpet waste, T_{11}=*Azotobacter*, T_{12}=PSB and T_{13}=*Azotobacter* + PSB. All the treatments were replicated thrice in randomized block design with both the variety. The yield and yield parameters like yield of rhizome per plant (g), fresh rhizome yield (q per ha), length of rhizome (cm) and width of rhizomes (cm) were recorded by standard methods. The fresh yield was recorded by weighing the rhizome at the time of harvesting in one square meter area. The weighing was done after cleaning the soil at turmeric rhizome. The yield per ha was recorded by the multiplication the value with ten thousand. For yield of rhizome per plant (g), ten random plants with same treatment combinations were taken and obtained the average results. The present data was angularly transformed before statistical analysis.

RESULTS AND DISCUSSION

The integration of bio- and inorganic fertilizers on yield and yield attributes of turmeric (Table 1) revealed that, the different treatments applied in both varieties of turmeric have well marked effect on rhizome yield. Application of T_6 (100% inorganic nitrogen + 100% inorganic phosphorus + *Azatobacter* + Phosphorus solublizing bacteria) recorded significantly higher fresh rhizome yield in both the varieties—Padrauna Local and NDH-18 (259.32 q per ha and 388.99 q per ha, respectively) which was closely followed by T_9 (50% inorganic nitrogen + 50% inorganic phosphorus + *Azotobacter* + Phosphorus solubliz-ing bacteria + 50% Nitrogen through carpet waste) in both the varieties—Padrauna Local and NDH-18 (252.56 q per ha and 378.84 q per ha). In treatment T_7 (50% inorganic nitrogen + 50% inorganic phosphorus + *Azotobacter* + 50% Nitrogen through carpet waste) and treatment T_{10} (25% inorganic nitrogen + 25% inorganic phosphorus + *Azatobacter* + Phosphorus solublizing bacteria + 75% Nitrogen through carpet waste) showed similar result in both the turmeric varieties—Padrauna Local (V_1) and NDH-18 (V_2) (223.24 q per ha and 334.87 q per ha, respectively). In respect of fresh rhizome yield, turmeric variety NDH-18 was found superior over variety Padrauna Local. The economic yield is a function of yield attributing characters like dry matter production and its accumulation in different plant parts. In the present study, the increase in rhizome yield with the application of T_6 (100% inorganic nitrogen + 100% inorganic phosphorus + *Azotobacter* + Phosphorus solublizing bacteria) can be traced back to the significant increase in the yield attributing characters over other treatments. Application of T_6 (100% inorganic nitrogen + 100% inorganic phosphorus + *Azotobacter* + Phosphorus solublizing bacteria) significantly increased the number and size of primary, secondary and tertiary rhizomes over all the other manures and RDF.

Table 1: Integrated influence of organic and inorganic fertilizers on yield attributes of turmeric.

Treatments	Length of rhizome (cm)		Width of rhizome (cm)		Yield of rhizome per plant (g)		Fresh rhizome yield (q/ha)	
	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2
T_1=Control (No application)	3.47	5.21	1.51	2.26	149.57	224.35	180.40	270.60
T_2=100% inorganic Nitrogen	4.26	6.38	1.84	2.77	183.22	274.83	220.99	331.48
T_3=100% inorganic Nitrogen + 100%P	4.48	6.71	1.94	2.91	192.57	288.85	232.26	348.40
T_4=100% inorganic Nitrogen+100%P+ *Azotobacter*	4.56	6.84	1.98	2.97	196.31	294.46	236.77	355.16
T_5=100% inorganic Nitrogen+100%P+ PSB	4.69	7.04	2.04	3.05	201.91	302.87	243.54	365.31
T_6=100% inorganic Nitrogen+100%P+ *Azotobacter*+PSB	5.00	7.49	2.17	3.25	215.00	322.50	259.32	388.99
T_7=50% inorganic Nitrogen+50%P + *Azotobacter*+50% N through carpet waste	4.30	6.45	1.86	2.80	185.09	277.63	223.24	334.87
T_8=50% inorganic Nitrogen+50%P + PSB +50% N through carpet waste	4.43	6.65	1.92	2.89	190.70	286.05	230.08	345.01
T_9=50% inorganic Nitrogen+50%P + *Azotobacter*+ PSB + 50% N through carpet waste	4.87	6.30	2.11	3.17	209.39	314.09	252.56	378.84
T_{10}=25% inorganic N_2 + 25%P + *Azotobacter*+PSB+75% N through carpet waste	4.30	6.45	1.87	2.80	185.09	277.63	223.24	334.87
T_{11}=*Azotobacter*	3.91	5.86	1.70	2.54	168.26	252.39	202.95	304.42
T_{12}=PSB	4.04	6.06	1.75	2.63	173.87	260.81	209.71	314.57
T13=*Azotobacter* + PSB	4.17	6.26	1.81	2.71	179.48	269.22	216.48	324.72
C.D. (P=0.05)	0.176		0.072		7.318		9.054	

These findings are in conformity with the findings of Vadiraj *et al.* (11) and Krishnamurthy *et al.* (7) in turmeric and Patil (10) and Khalil *et al*. (6) in onion.

The increase in yield parameters and final yield with the application of T_6 (100% inorganic nitrogen + 100% inorganic phosphorus + *Azotobacter* + Phosphorus solublizing bacteria) and T_9 (50% inorganic nitrogen + 50% inorganic phosphorus + *Azotobacter* + Phosphorus solublizing bacteria + 50% Nitrogen through carpet waste) is attributed to increased dry matter production and its accumulation in different plant parts which in turn reflects the translocation of photosynthates from source to sink. Thus, due to higher photosynthates the rhizome characters might have developed to the maximum extent and resulted in higher rhizome yields. Similar results were obtained Blay *et al.* (1) in onion and Khalil *et al.* (6) in turmeric. The beneficial effects of these treatments on yield and yield attributes of both varieties of turmeric could be attributed to the fact that after decomposition and mineralization, the organic manures supply available nutrients directly to the plants and also had stabilizing effect on fixed form of nutrients in soil, besides, the nutrients supplying capacity. These organic manures build the soil organic matter reservoir, which increases the water holding capacity, porosity, structural stability in the soil. Thus, improvement in soil physical and chemical environment must have helped in proliferation of beneficial soil microbial population, improved enzymatic activity, encouraged proliferation of roots which helped in absorption of more water and nutrients from larger area. This must have been responsible for higher biomass production *vis-a-vis* more rhizome yield. The difference in yield, yield parameters and dry

matter production could also be attributed to the significant increase in the growth components like plant height, number of leaves, leaf size, leaf area and number of tillers. All these parameters have an indirect positive impact on the yield components and yield of turmeric. The data in Table 1 revealed that application of treatment T_6 (100% inorganic nitrogen + 100% inorganic phosphorus + *Azotobacter* + Phosphorus solublizing bacteria) recorded significantly wider rhizome in both the turmeric varieties Padrauna Local and NDH-18 (2.17 cm. and 3.25 cm, respectively), which was closely followed by T_9 (50% inorganic nitrogen + 50% inorganic phosphorus + *Azotobacter* + Phosphorus solublizing bacteria + 50% Nitrogen through carpet waste) over all treatments. In treatment T_7 (50% inorganic nitrogen + 50% inorganic phosphorus + *Azotobacter* + 50% Nitrogen through carpet waste) and treatment T_{10} (25% inorganic nitrogen + 25% inorganic phosphorus + *Azotobacter* + Phosphorus solublizing bacteria + 75% Nitrogen through carpet waste) was found similar. In the respect of width of rhizome turmeric variety NDH-18 was found superior over Padrauna Local. In the present investigation, application of treatment T6 (100% inorganic nitrogen + 100% inorganic phosphorus + *Azotobacter* + Phosphorus solublizing bacteria) recorded significantly higher values for length of rhizome in both the turmeric varieties Padrauna local and NDH-18 (5.00 and 7.49 cm, respectively), which was closely followed by T_9 (50% inorganic nitrogen + 50% inorganic phosphorus + *Azotobacter* + Phosphorus solublizing bacteria + 50% Nitrogen through carpet waste) (4.87 and 6.30 cm, respectively) over all treatments. In all, length of rhizome turmeric variety NDH-18 was found superior over Padrauna Local. Similar trend was also observed in case of yield of rhizome per plant in both the varieties of turmeric.

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EFFECT OF ENVIRONMENTAL FACTORS ON *Phytophthora* BLIGHT DEVELOPMENT OF COLOCASIA

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ABSTRACT: Progress of *Phytophthora* blight of taro (*Colocasia esculenta* var. *antiquorum*) caused by *Phytophthora colocasiae* Racib. was found greatly influenced by environmental factors prevalent under field condition. Per cent plant infection, disease intensity, coefficient of disease index and related progress of disease were periodically recorded on a susceptible variety Narendra Arvi-2. The maximum and minimum infection rate ('r') was observed in 33rd and 32nd standard week during 2006 and 2007. Disease intensity and per cent plant infection were significantly but positively correlated with rainfall and relative humidity in both the year. Disease intensity and per cent plant infection were negatively but none significantly correlated with maximum temperature in 2007 but positively correlated in the year 2006. However, rest of the weather factors were positively correlated to disease intensity and per cent plant infection in both the years. Relative humidity, cumulative rainfall and sunshine hour were found most congenial environmental factors for leaf blight development of taro.

Keywords: *Taro, Phytophthora blight, environment, regression, correlation.*

Leaf blight of taro is caused by a destructive fungus *Phytophthora colocasiae* Racib. which is host specific and widely distributed disease on a large number of crops. Taro (*Colocasia esculenta* var. *antiquorum*) is known as "*Arvi*" / "*Ghuiya*" in Hindi. The disease causes damage to all parts and high cormel yield losses upto 70% (Jackson and Gollifer, 2). *P. colocasiae* appears under warm and humid conditions, on foliage severe blight in congenial environmental conditions resulting significantly loss in yield. In India, crop growth and appearance of disease coincide with the onset of monsoon making the conditions most favourable for explosive development of disease (Vanderplank, 8). The disease assumes severe from in areas having high relative humidity with frequent rainfall. The relationship between disease progression and weather factors is of paramount importance for effective disease development. The present study was conducted to determine leaf blight intensity was subjected to correlation and regression analysis with weather factors for the specific periods of the same year, to determine their relationship.

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MATERIALS AND METHOS

The present investigations were conducted in the Main Experiment Station, Vegetable Science, N.D.U.A.T., Kumarganj, Faizabad. Cormels of susceptible variety Narendra Arvi-2 were sown in plot size 3.6 m x 3.0 m (spacing 60 x 30 cm) in three replications on 15 March, 2006 and 2007 using recommended dose of fertilizers for the study of role of weather factors on disease development. Development of disease in terms of per cent plant infection, disease intensity was recorded at 7 days interval periodically, after the first appearance of the disease in both the year. Disease intensity was recorded on the basis of 10 plants randomly selected from each plot at random from each replication of using 0-5 scale (Prasad, 5). Simultaneously, meteorological data on temperature (°C) (minimum and maximum), relative humidity (%), cumulative rainfall (mm) and sunshine (hour) were also recorded for the intervening period between two consecutive disease intensity. Data recording and bivariate correlation analysis was conducted to determine the

effect of individual as well as combined weather factors on disease development. Weather parameters were recorded from Meteorological Observatory located at University campus. Leaf blight intensity was subjected to correlation and multiple regression analysis with weather factors for the specific periods of the same year, to determine their relationship. The prediction equation used was $Y = a+b_1x_1 + b_2x_2 + ... b_nx_n$.

where,

Y = Per cent disease intensity

b_1 to b_n = Partial regression coefficient (slop)

a = Intercept

The disease progress was also measured by calculating apparent infection rate

('r') as per method given by Vanderplank (8) using logistic equation.

$$r \quad \frac{2.303}{t_2 \quad t_1} \log_e \frac{X_2 (1 \quad X_1)}{X_1 (1 \quad X_2)}$$

where,

r = apparent infection rate per unit per day

$t_2 \quad t_1$= time interval between two observations.

X_1 and X_2 = proportion of disease plant parts at t_1 and t_2 time intervals

1 X_1 and 1 X_2 = proportion of healthy plant parts at t_1 and t_2 time intervals

$\log_e$ = natural log

The relative progress of disease (RPD) as calculated under following formula

Relative progress of disease = Disease intensity in present week- Disease intensity of previous week

Coefficient of disease index calculated under following formula

$$\text{CODEX} = \frac{\text{PPI} \quad \text{PDI}}{100}$$

where,

CODEX = Coefficient of disease index

PPI = Per cent plant infection

PDI = Per cent disease intensity

Disease intensity and per cent plant infection were processed, correlated and interpreted with different epidemiological factors to find out the positive correlation for prediction of disease development.

RESULTS AND DISCUSSION

The results depicted in Table 1 and on weather parameters (Fig. 1 and 2) revealed that for the first time the disease appeared on 16th July, *i.e.,* 28th standard week of 2006 and the per cent plant infection, disease intensity and coefficient of disease index increased gradually till maturity and reached its maximum 98.07, 66.06 and 64.78 per cent at 34th standard week (August 27-September 2), however, the relative progress of disease and infection rate ('r') were maximum in 34th standard week (August 27-September 2) and 33rd standard week (August 20-26) which was 13.85 per cent and 0.617 unit per day, respectively with minimum temperature (26.20 °C), maximum temperature (33.00 °C) sunshine hours (4.40) and minimum temperature (26.50 °C), maximum temperature (34.00 °C) with relative humidity 78.10 (%), rainfall (34.50 mm) and sunshine hours (8.50) for infection rate per unit per day and followed by infection rate ('r') was observed in 30th standard week (July 30-August 5) with 0.519 per unit per day at minimum temperature (26.20 °C), maximum temperature (32.30 °C), average relative humidity (80.10%), cumulative rainfall (36.40 mm) and sunshine hours (7.80) respectively. The minimum infection rate ('r') was observed in 32nd standard week (August 13-19) with (0.162) per unit per day at minimum temperature (26.00 °C), maximum temperature (32.40 °C) relative humidity (77.80 %), cumulative rainfall (6.20 mm) and sunshine hours (7.50), respectively. There are three weather factors i.e., average relative humidity, cumulative

rainfall and sunshine hours very congenial for leaf blight development.

During 2007, the first appearance of leaf blight was noticed on 20th July *i.e.* 28th standard week (July 16-22) and the per cent plant infection, disease intensity and coefficient of disease index increased gradually till maturity of crop and reached upto 96.15, 73.27 and 70.45 per cent at 34th standard week (August 27-September 2). However, the relative progress of disease and infection rate ('r') were maximum in 34th standard week (August 27-September 2) and 30th standard week (July 30-August 5) was 15.00 per cent and 0.601 unit per day, respectively at minimum temperature (26.40 °C), maximum temperature (31.90 °C), relative humidity (79.90%), cumulative rainfall (15.60 mm) and sunshine hours (3.80) and minimum temperature (24.50 °C), maximum temperature (30.20 °C), average relative humidity (84.90%), cumulative rainfall (22.20 mm) and sunshine hours (4.47), respectively which followed by infection rate ('r') was observed in 34th standard week (August 27-September 2) with (0.528) per unit per day at minimum temperature (26.40 °C), minimum temperature (31.90 °C), average relative humidity (79.90%), cumulative rainfall (15.60mm), sunshine hours (3.80), respectively. The minimum infection rate ('r') was observed in 31st standard week (August 6-12) with 0.133 per unit per day at minimum temperature (26.00 °C), maximum temperature (32.40 °C), average relative humidity (81.70%), cumulative rainfall (49.20 mm) and sunshine hours (2.50), respectively. These are the similar weather factors during the year 2006 very congenial for leaf blight development.

These results also corroborate the findings of earlier workers (Pathak and Mishra, 3; Shakywar *et al.,* 7 and Yadav *et al.,* 9). Garde and Joshi (1) have reported various weather factors that influenced leaf blight incidence of colocasia.

Simple correlation

Simple correlation between per cent plant infection, disease intensity were also found significantly and positively correlated with total rainfall for the 2006 (r=0.834, 0.776) and 2007 (r=0.632, 0.653) year respectively (Table 2). Similar trend was seen for the sunshine hours in the first (r=0.798, 0.772) and second (r=0.698, 0.665) year also. Disease intensity were significantly and positively correlated with average relative humidity for the first (r=0.635) year. Per cent plant infection and disease intensity were negatively but non-significantly correlated with maximum temperature in the second year. However, rests of the weather factors were positively but non-significantly correlated to per cent plan infection and disease intensity in the 2006 and 2007 year. Thus, it is clearly indicates that total rainfall and sunshine hours favoured disease development during both years.

Multiple correlation and regression equation

The multiple correlation coefficient between leaf blight intensity and group of independent variables during crop season 2006 and 2007 were found 0.930 and 0.957, which indicates that 93.00 and 95.70 per cent leaf blight intensity was caused by average relative humidity, rainfall and sunshine hours. In the year 2006, regression equation $y = (-0.3090.03) + 101.54\ x_1\ (-11.17)\ X_2 + 10.36\ X_3 + (-0.351)\ x_4 + 94.8\ X_5$ showed minimum temperature influenced disease intensity followed by average relative humidity, sunshine hours, maximum temperature and total rainfall, respectively (Table 3).

Significant and positive correlation between per cent plant infection and disease intensity with rainfall and relative humidity was also recorded by Pouono *et al.* (4) and Radford (1967). Yadav *et al.* (9) have also found significant and positive correlation between leaf blight intensity with minimum temperature, maximum temperature, relative humidity, rainfall, sunshine hours and number of rainy days. Thus, the findings in the present investigation are well supported by the results of previous workers.

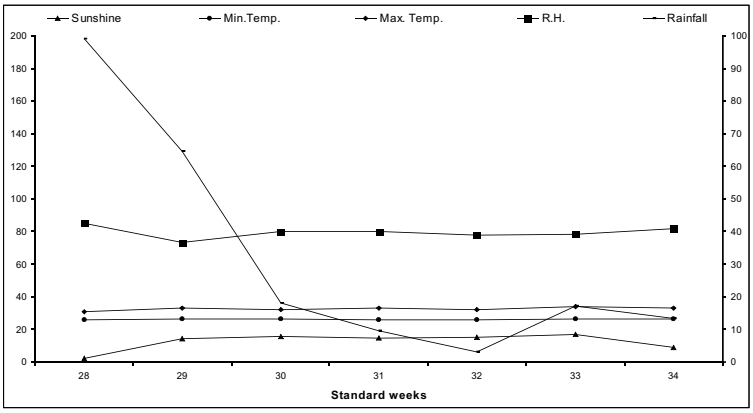

Fig. 1

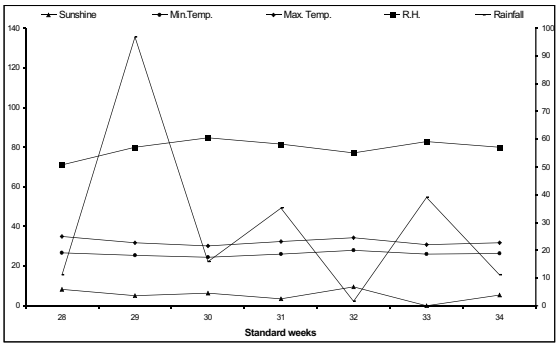

Fig. 2

Table 1: Effect of meteorological factors on leaf blight of taro variety Narendra Arvi-2.

Standard week	PPI		PDI		RPD		CODEX		Infection rate per unit per days	
	2006	**2007**	**2006**	**2007**	**2006**	**2007**	**2006**	**2007**	**2006**	**2007**
28	5.76 (13.88)	3.80 (11.24)	3.87 (11.34)	4.13 (11.72)	0.00	0.00	0.22	0.16	0.00	0.00
29	15.38 (23.08)	13.46 (21.51)	9.25 (17.70)	12.52 (20.71)	5.38	8.39	1.42	1.69	0.349	0.439
30	46.15 (42.77)	48.07 (43.88)	21.12 (27.35)	26.21 (30.78)	11.87	13.69	9.74	12.60	0.519	0.601
31	59.61 (50.52)	57.69 (49.40)	34.71 (36.08)	36.76 (37.31)	13.59	10.55	20.69	21.21	0.187	0.133
32	71.15 (57.49)	73.07 (58.72)	43.24 (41.10)	43.51 (41.25)	8.53	6.75	30.76	31.80	0.162	0.221
33	94.23 (76.07)	80.76 (63.96)	52.21 (46.25)	58.27 (49.74)	8.97	14.76	49.19	47.06	0.617	0.150
34	98.07 (81.98)	96.15 (78.65)	66.06 (54.35)	73.27 (58.84)	13.85	15.00	64.78	70.45	0.376	0.528
C.D. (P=0.05)	11.75	11.21	7.76	8.39						

Figures in parentheses are arcsine transformed value

PPI = Per cent plant infection PDI = Per cent disease intensity

RPD = Related progress disease CODEX = Coefficient of disease index

Table 2: Simple correlation between per cent plant infection, per cent disease intensity and meteorological factors during 2006 and 2007.

		2006		2007	
		PPI	PDI	PPI	PDI
Temperature °C	Minimum	0.248	0.198	0.237	0.226
	Maximum	0.535	0.584	-0.319	-0.322
Average relative humidity (%)		0.003	0.635*	0.465	0.565
Total rainfall (mm)		0.834**	0.776**	0.632*	0.653*
Sunshine (hours)		0.798**	0.772**	0.698*	0.665*

* Significant at 5% ** Significant at 1%

Table 3: Regression of leaf blight intensity and meteorological factors on taro variety.

Year	Regression equation	R^2
2006	$Y = (-3090.03) + 101.54\ X_1 + (-11.17)\ X_2 + 10.36\ X_3 + (-0.351)\ X_4 + 9.48\ X_5$	0.930
2007	$Y = (-201.37) + 43.25\ X_1 + (-29.07)\ X_2 + 0.922\ X_3 + (=0.23)\ X_4 + 1.00\ X_5$	0.957

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EFFECT OF CHEMICAL AND BIO-FERTILIZERS ON QUALITY OF ONION

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ABSTRACT: The present investigation comprising the supplementation of chemical and bio-fertilizers for onion crop was carried out under field conditions at Babasaheb Bhimrao Ambedkar University, Lucknow during *rabi* season of 2010-2011. The experiment comprised of four levels of chemical fertilizers and six levels of biofertilizers. The maximum ascorbic acid, reducing sugar and total sugars were found with the application of T_{11} (100 kg N + 50 kg P + 70 kg K/ha + 2 kg/ha *Azotobacter* + 2 kg/ha *Phosphobacteria*). The maximum TSS, non-reducing sugar, phosphorus and calcium were found under the treatment T_{12} (100 kg N + 50 kg P + 70 kg K/ha + 2 kg/ha *Azotobacter* + 1.9 kg/ha VAM). The minimum values were found under the control i.e. T_1. Results obtained by the application of inorganic fertilizers with biofertilizers exhibited significant effect on various parameters studied under the investigation.

Keywords: *Azotobacter, phosphobacteria, VAM, chemical fertilizers, onion.*

Onion (*Allium cepa* L.), belonging to the family Alliaceae, is a herbaceous annual for the edible bulb production and biennial for the seed production. Onion is one of the most important crop grown in India and worldwide. Moreover, onion is the only vegetable in which India figures prominently in the world for production and export. Raw onion has an antiseptic value through the alimentary canal. It promotes bile production and reduces blood sugar. It is rich in minerals like phosphorus and calcium, vitamin C, protein and carbohydrates. In order to meet the increasing demand of the consumers and fill the gap in off-season, onion is now gaining popularity as *kharif* season crop too. Crop production of onion is affected by several factors. Biofertilizers have recently gained with momentum for affecting the sustainable increase in crop yield under various agro climatic conditions. Biofertilizers are live carrier based microbial preparations used in agriculture as low input resources to enhance the availability of plant nutrients or promote the growth by way of synthesizing growth factors (Subba Rao *et al.,* 5). They are low cost effective, inexpensive and ecofriendly sources of nutrient. Role of biofertilizer on the crop growth and yield was documented by Yogita and Ram (6). *Azotobacter* fixes atmospheric nitrogen independently near the root zone, thus, enhancing the available nitrogen to the soil, whereas phosphobacteria solublize the soil phosphorus and make them easily available for the plants. Vesicular-Arbuscular Mycorrhizae (VAM) play a vital role in development of stronger root system, improved growth (Zandavalli *et al.,* 7), nutrient uptake, increase tolerance of host roots to soil borne pathogens (Nelson and Achar, 3).

Uses of biofertilizers in onion production, to at least partially supplement its nutrient demand and to improve soil fertility by way of the integration of different sources of plant nutrients is desired. Onion has a good response for biofertilizer inoculation due to real nature of their root morphology. Keeping in view the above facts, present study was undertaken on quality parameters of onion applying various biofertilizers and graded level of chemical fertilizers.

MATERIALS AND METHODS

The present investigation was carried out at the Horticultural Research Farm of Babasaheb Bhimrao Ambedkar University, Lucknow during the *rabi* season of 2010-2011. The experiment comprised of four levels of inorganic fertilizers viz. 1. $N_0P_0K_0$ (Without inorganic fertilizers) C_0, 2.

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$N_1P_1K_1$ (100 kg N + 50 kg P + 70 kg K/ha) C_1, 3. $N_2P_2K_2$ (75 kg N + 37.5 kg P + 52.5 kg K/ha) C_2, and 4. $N_3P_3K_3$ (50 kg + 25 kg P + 35 kg K/ha) C_3; and six levels of biofertilizers *viz.* 1. Uninoculated (Without biofertilizers) B_0, 2. *Azotobacter* (2 kg /ha) B_1. 3. *Phosphobacteria* (PSB) (2 kg/ha) B_2, 4. Vesicular-Arbuscular Mycorrhizae (VAM) (1900 kg/ha) B_3, 5. *Azotobacter* (2 kg/ha) + Phosphobacteria (2 kg/ha) B_4, and 6. Azotobacter (2 kg/ha) + VAM (1900 kg/ha) B_5. Thus, having a total of 24 treatment combinations *i.e.* T_1 (C_0B_0), T_2 (C_0B_1), T_3 (C_0B_2), T_4 (C_0B_3), T_5 (C_0B_4), T_6 (C_0B_5), T_7 (C_1B_0), T_8 (C_1B_1), T_9 (C_1B_2), T_{10} (C_1B_3), T_{11} (C_1B_4), T_{12} (C_1B_5), T_{13} (C_2B_0), T_{14} (C_2B_1), T_{15} (C_2B_2), T_{16} (C_2B_3), T_{17} (C_2B_4), T_{18} (C_2B_5), T_{19} (C_3B^0), T_{20} (C_3B_1), T_{21} (C_3B_2), T_{22} (C_3B_3), T_{23} (C_3B_4) and T_{24} (C_3B_5), respectively. The quantity of fertilizers was given as per treatment. The entire amount of phosphorus and potassium along with half dose of nitrogen were applied as basal dose during the field preparation and rest amount of nitrogen was applied as top dressing in two- equal split doses at 30 and 60 days after transplanting. *Azotobacter, Phosphobacteria* and Vesicular-Arbuscular Mycorrhizae were applied at the time of transplanting i.e. *Azotobacter* and PSB as seedling root treatment and VAM as soil application. The seedling transplanting was done in the last week of December 2010 in the evening at 10 x 15 cm spacing. The experiment was laid out in R.B.D with twenty four treatments and replicated thrice. All the standard package of practices and plant protection measures were timely adopted to raise the crop successfully. Five randomly selected bulbs from each replication were utilized for recording observations on TSS, ascorbic acid, reducing sugar, non-reducing sugar, total sugars, phosphorus and calcium. Statistical analysis of the data was done as per standard method.

RESULTS AND DISCUSSION

The observations recorded on TSS, ascorbic acid, reducing sugar, non-reducing sugar, total sugars, phosphorus and calcium maturity was significantly influenced by the interaction of inorganic fertilizers and biofertilizers. Table 1 clearly indicates that the maximum TSS (13.27 °Brix) was recorded with the application of T_{12} (100 kg N + 50 kg P + 70 kg K/ha + 2 kg/ha *Azotobacter* + 1.9 kg/ha VAM) which remained at par with treatment T_{11} (100 kg N + 50 kg P + 70 kg K/ha + 2 kg/ha *Azotobacter* + 2 kg/ha *Phosphobacteria*) followed by T_{18} (75 kg N +37.5 kg P + 52.5 kg K/ha + 2 kg/ha *Azotobacter* + 1.9 kg/ha VAM) and T_{17} (75 kg N +37.5 kg P + 52.5 kg K/ha + 2 kg/ha *Azotobacter* + 2 kg/ha *Phosphobacteria*). Whereas, the minimum TSS (9.67 °Brix) was recorded under control. These results are in confirmity with the findings of Gurubathem *et al.* (1). Higher ascorbic acid was obtained with the application of T_{11} (100 kg N + 50 kg P + 70 kg K/ha + 2 kg/ha *Azotobacter* + 2 kg/ha *Phosphobacteria*) which remained at par with treatment T_{12} (100 kg N + 50 kg P + 70 kg K/ha + 2 kg/ha *Azotobacter* + 1.9 kg/ha VAM). Whereas, the lower ascorbic acid was obtained under control treatment. The highest reducing sugar (14.23%) and total sugars (43.81 %) were recorded with the treatment T_{11} (100 kg N + 50 kg P + 70 kg K/ha + 2 kg/ha *Azotobacter* + 2 kg/ha *Phosphobacteria*) which was at par with T_{17} (75 kg N +37.5 kg P + 52.5 kg K/ha + 2 kg/ha *Azotobacter* + 2 kg/ha *Phosphobacteria*) followed by T_{12} (100 kg N + 50 kg P + 70 kg K/ha + 2 kg/ha *Azotobacter* + 1.9 kg/ha VAM), respectively over the control treatment. The highest non-reducing sugar (29.87 %) was recorded with the treatments T_{17} (75 kg N +37.5 kg P + 52.5 kg K/ha + 2 kg/ha *Azotobacter* + 2 kg/ha *Phosphobacteria*) which were at par with T_{12} (100 kg N + 50 kg P + 70 kg K/ha + 2 kg/ha *Azotobacter* + 1.9 kg/ha VAM), T_{18} (75 kg N +37.5 kg P + 52.5 kg K/ha + 2 kg/ha *Azotobacter* + 1.9 kg/ha VAM) and T_{11} (100 kg N + 50 kg P + 70 kg K/ha + 2 kg/ha *Azotobacter* + 2 kg/ha *Phospho-bacteria*), respectively over the control treatment. Similar results were also corroborated by Ram and Rajput (4). The maximum phosphorus content (35.00 mg/100g) and calcium content (24.33 mg/100g) was found under the treatment T_{12} (100 kg N + 50 kg P + 70 kg K/ha + 2 kg/ha *Azotobacter*

Table 1: Effect of chemical and bio-fertilizers on different bio-chemical parameters of onion.

Treatments	T.S.S (%)	Ascorbic acid (%)	Reducing sugar (%)	Non-reducing sugar (%)	Total sugars (%)	Phosphorus (mg/100g)	Calcium (mg/100g)
T_1	9.67	7.37	10.63	24.86	35.49	26.33	18.00
T_2	9.93	7.59	11.12	25.94	37.06	28.33	18.33
T_3	10.13	7.66	11.45	25.83	37.28	28.00	19.00
T_4	10.47	7.92	11.28	26.42	37.70	29.00	20.33
T_5	10.67	7.85	11.38	26.51	37.89	29.33	20.67
T_6	10.93	7.92	11.61	26.81	38.48	29.33	20.33
T_7	12.00	8.14	11.88	27.12	39.01	30.00	21.33
T_8	12.13	8.18	12.22	26.92	39.14	30.67	21.33
T_9	12.13	8.36	12.13	28.21	40.34	30.33	20.67
T_{10}	12.33	8.32	12.28	28.59	40.87	31.33	20.67
T_{11}	13.07	10.34	14.23	29.57	43.81	33.00	23.00
T_{12}	13.27	10.19	13.00	29.80	42.80	35.00	24.33
T_{13}	12.07	8.32	12.48	26.19	38.67	30.00	20.33
T_{14}	11.60	8.29	12.42	26.33	38.76	29.67	20.67
T_{15}	12.00	8.47	12.32	27.34	39.33	30.00	20.33
T_{16}	11.93	8.36	12.43	28.00	40.42	30.33	20.67
T_{17}	12.80	9.46	13.33	29.87	43.20	33.00	22.67
T_{18}	12.80	9.90	12.78	29.80	42.69	32.33	22.33
T_{19}	10.80	8.07	11.81	26.52	38.33	29.33	20.33
T_{20}	11.20	8.10	11.34	26.93	38.27	30.00	20.00
T_{21}	11.60	8.43	11.70	27.97	39.67	30.33	20.67
T_{22}	11.47	8.47	12.17	27.17	39.33	30.67	20.00
T_{23}	12.07	9.20	12.63	28.71	41.33	32.33	22.00
T_{24}	12.20	9.31	12.53	29.03	41.55	31.67	21.67
C.D. (P=0.05)	0.37	0.13	0.45	0.91	0.75	1.03	0.77

+ 1.9 kg/ha VAM) followed by T_{11} (100 kg N + 50 kg P + 70 kg K/ha + 2 kg/ha *Azotobacter* + 2 kg/ha *Phosphobacteria*) and T_{17} (75 kg N +37.5 kg P + 52.5 kg K/ha + 2 kg/ha *Azotobacter* + 2 kg/ha *Phosphobacteria*), respectively. Whereas, minimum phosphorus content (26.33 mg/100g) and calcium content (18.00 mg/100g) were found under the control *i.e.* T_1 confirming the report of Kumar and Mangal (2).

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MANAGEMENT OF PHOMOPSIS LEAF BLIGHT OF BRINJAL THROUGH DIFFERENT FUNGICIDES AND BIOPESTICIDE

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ABSTRACT: Phomopsis leaf blight caused by *Phomopsis vexans* is an important disease of Brinjal (*Solanum melongena* L.) in Eastern U.P. Therefore, efficacy of fungicides and biopesticides were tested *in-vitro* and *in-vivo*. Bavistin (0.1%), Vitavax (0.1%), Blitox-50 (0.2%), and Ridomil (0.15%) proved to be the most effective in inhibiting the growth of pathogen *in-vitro* and controlling the disease in the field. Biopesticide, Nimbidine was also proved effective, but slightly less effective than systemic fungicide except Indofil M-45, Nimbidine being a safe eco-friendly and economical bioproduct which can be used in the management of the disease.

Key words: *Brinjal, Phomopsis leaf blight, Phomopsis vexans, management, fungicide, biopesticide.*

Brinjal or egg plant (*Solanum melongena* L.) is one of the most common, popular vegetable crop grown in almost worldwide. India is considered to be the centre of origin of cultivated brinjal, from where it spread to the other parts of the world (Chaudhury and Kalda, 2). Brinjal was observed to suffer from Phomopsis leaf blight and fruit rot, caused by *Phomopsis vexans*, is considered to be the most destructive disease of brinjal (Kumar, 5). Phomopsis blight was first time reported in India in Bombay (Uppal *et al.,* 9). Not much work has been done on this disease except that the report of its occurrence. Recently, the disease has assumed serious proportion damaging the crop to the tune at 35-40 per cent. Therefore, it was felt necessary to study the management of disease through the use of fungicides and biopesticide.

MATERIALS AND METHODS

The efficacy of fungicides and biopesticides against the pathogen *in-vitro* was tested by poison food technique described by Schmitz (8) using PDA Medium. Bavistin,Vitavax, Blitox-50, Chlorothionil, Ridomil, Indofil M-45, Zineb, Kitazin, Captofol and one antibiotic Streptocycline (0.2%) and biopesticide Nimbidine, *Bael* and *Ashok* extract (1.0%) were used (Table 1).

Extracts of botanicals-*Bael* (*Aegle mormelos*) and *Ashok* (*Polyalthia longifolia*) were prepared by crushing their leaves (100 g each) in 100 ml of sterilized distilled water. The extract were then filtered through a muslin cloth and centrifuged for 30 min at 5000 rpm. The extracts were sterilized by passing them through a Millipore filter (0.22 m pore size) using a swimmy filter adapter. The materials were dried at room temperature (25+2°C) for 6 hours to remove the traces of water. Subsequently 1% concentration of the extract of each botanical was used for bio-assay test by food poison technique. The radial growth of *Phomopsis vexans* in three replications were recorded separately and their averages were taken. The per cent inhibition over control was calculated by the formula (Bliss, 1) as given below :

$$\text{Per cent inhibition over control} \quad ..... \quad \frac{C-T}{C} \times 100$$

Where, C= growth of fungus in control.

T= growth of fungus in treatment.

In order to find out a suitable control of the disease, efficacy of fungicides and biopesticides were assessed in field trial at Student Research Farm of T.D.P.G. College, Jaunpur during *Kharif* season 2005-2006 and 2006-2007. The disease susceptible variety "Arka Keshav" of brinjal was transplanted in 4x4 m plot size in Randomized Block Design with 4 replications. Sixty days old

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Table 1: Effect of fungicides and biopesstcides on colony growth of *Phomopsis vexans* on P.D.A.

Product	Conc. w/v	Av. Colony diameter after 5 day (mm)	Per cent inhibition over control
Bavistin	0.10	0.0	100
Vitavax	0.10	0.0	100
Blitox-50	0.20	0.0	100
Ridomil	0.20	0.0	100
Nimbidine	0.50	2.50	97.05
Inofil M-45	0.20	4.95	94.17
Chlorothonil	0.20	7.95	90.67
Kitazin	0.20	9.20	89.17
Zineb	0.20	10.12	88.94
Captofol	0.20	14.15	83.35
Bel extract	1.00	16.30	80.82
Ashok extract	1.00	19.25	77.35
Streptocycline	0.20	26.00	69.41
Control	-	85.0	-
C.D. (P = 0.05)	-	4.98	-

Table 2: Efficacy of fungicides and biopesticides against Phomopsis leaf blight of brinjal under field condition.

Product	Dose %	Disease incidence %			Yield (q/ha)		
		2006	2007	Mean	2006	2007	Mean
Bavistin	0.10	9.25 (17.70)	8.00 (16.42)	8.62 (17.07)*	228	239	235.5
Vitavax	0.10	9.10 (17.55)	10.20 (18.62)	9.65 (18.09)	238	223	230.5
Blitox-50	0.20	11.75 (20.04)	12.00 (20.26)	11.86 (20.14)	228	219	223.5
Ridomil	0.20	12.50 (20.70)	13.30 (21.38)	12.90 (21.04)	216	208	212.0
Nimbidine	0.50	15.25 (22.90)	14.60 (22.46)	14.92 (22.74)	196	203	199.5
Indofil-45	0.20	17.56 (24.77)	18.25 (25.29)	17.90 (25.02)	189	182	185.5
Control	—	32.20 (34.57)	33.80 (35.54)	33.00 (35.06)	140	136	138.0
C.D. (P = 0.05)		(2.43)	(2.15)	(2.05)	6.5	5.3	5.9

* Figures in parenthesis are angular transformed value.

plants were artificially inoculated by spraying of mycelium cum spore suspension of the pathogen and the plots were irrigated from time to time, to maintain proper moisture.The five fungicides *viz*. Bavistin and Vitavax (0.1%), Blitox-50 (0.2), Ridomil (0.2%), Indfil M-45(0.2%) and one biopesticide Nimbidine (0.5%) were used as spray (Table 2). The first spray was done at the onset of disease followed by two more spray at 15 days intervals. The control plots were sprayed with water only. For recording the disease intensity one hundred randomly selected leaves per plot were examined after 15 days of the last spray and the percentage of disease intensity was transformed into angles and analysed statistically. Yield was estimated on plot basis without considering the border rows in q/ha.

RESULTS AND DISCUSSION

The results presented in (Table 1) indicate that all the fungicides, plant extracts and bio-pesticides were significantly superior over control in inhibiting the growth of the pathogen *in-vitro*. Bavistin, Vitavax, Blitox-50 and Ridomil were the most effective fungicides and they completely inhibited the growth of pathogen. Nimbidine and Indofil M-45 were found to be the next best in inhibiting the growth of pathogen. These were statistically at par and showing 97.05 and 94.17 per cent inhibition over control, respectively. The Captafol was the least effective fungicide. *Bael* and *Ashok* extracts inhibited 80.82 and 77.35 per cent growth of pathogen and appeared statistically at par to each other. The radial growth of the pathogen in the case of rest of fungicides varied from 7.95 to 14.15 mm that showed their ineffectiveness. The finding of Mohanty *et al.* (6) also confirmed the effectiveness of Bavistin, Blitox -50, Ridomil and Indofil M-45 in checking the growth of *P. vexans* under laboratory condition. Mohanty *et al.* (7) observed fungicidal properties of the *Bael* and *Ashok* leaf extract against *P. vexans in-vitro.*

The results of field test with five fungicides and one bio-pesticide Nimbidine (Table 2) indicate their effectiveness in managing the disease. Spraying of Bavistin (0.1%), and Vitavax (0.1%) at the intervals of 15 days was more effective in minimizing the disease incidence and increasing the yield and proved statistically at par. Highest yield of 235.5 q/ha was obtained with Bavistin followed by Vitavax 230.5 q/ha. The next effective fungicide was Blitox-50 (0.2%) which showed 11.86 per cent disease and 223.5 q/ha yield. Indofil-45 (0.2%) proved to be the least effective one. The bio-pesticide, Nimbidine was numerically better than Indofil M-45 but was at statistically different showing mean disease incidence 14.92 and 199.5 q/ha yield against 31 per cent disease and 182.5 q/ha yield in water sprayed check plots.

The performance of systemic fungicide was better than non-systematic fungicide and it could be possible to control the disease through the spraying of fungicide on brinjal. Observation of Das (3) on control of Phomopsis blight of Brinjal by 3 spraying of Bavistin and Indofil M-45 support the observation regarding foliar sprays. Similarly, Islam and Pan (4) suggested that Phomopsis blight of brinjal can be managed by the spraying of Bavistin and Vitavax.

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Research Note :

CHIRONJEE : A PROMISING TREE FRUITS OF DRY SUBTROPICS

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Keywords : *Chironjee, deciduous, dry subtropics, minor fruit.*

Chironjee (*Buchanania lanzan*) is a common tree in dry deciduous forests. It is endemic to tropical dry deciduous forest of India. In english language it is known as little gooseberry tree (Janick and Paull, 3). It is also known as Cudappah almond or almondette. *Chironjee* fruits are considered as one of the delicious wild fruits. Its seeds are edible and are regarded as substitute for almond nuts. These seeds, in many cases are rushed to generate a powder for flavouring or use as spice in many Indian dishes. Besides, *chironjee* nuts are occasionally useful to thicken sauces and stews. The kernels have a pleasant, sub acidic flavour and are eaten raw or roasted. It is a high value minor fruit plant. However, it is yet confined to the forest area as stray plantation. The tribals collect chironjee fruits and sale them in local market. For them it forms the backbone of economy. In view of utility and commercial demand, the species needs to bring under commercial farming.

Chironjee is regarded for its high value kernel. It is a common substitute of almond amongst dry fruits. Its kernel oil is useful in curing glandular swellings of the neck. Chironjee paste is excellent skin conditioner. Besides fruit, its bark finds uses in natural varnish and is used for tanning also. Gum exudates obtained from tree trunk are used for dressing textile. Gum is also useful in treating diarrhoea, intercostal and rheumatic pains. Leaves are used in the treatment of skin diseases. Fruits are used in treating cough and asthma. The leaves possess cordiotonic properties. Leaf powder is a common cure for wounds. They constitute high class feed for cattle. The roots are acrid, astringent, cooling, depurative and constipating, and are useful in treatment of diarrhoea. It is a good species for growing over bare hill slopes. The tree serves as host of rearing kusumi strain of lac.

Thus, *chironjee* has wonderful utilifarious attributes. In view of this, a detail account of chironjee cultivation has been furnished hereunder to help favour its cultivation beyond wild ecosphere.

Chemical Composition

Chironjee fruits as well as kernel are very nutritious. Its fruits contain 74.3 % moisture, 2.2 % protein, 0.8 % fat, 1.5 % fibre, 19.5 % carbohydrate, 78 mg/100 g calcium and 28 mg/100 g phosphorus. Its calorific value is 49 k-cal/100 g. Its kernel contains- moisture 3 %, protein 19 %, fat 59.1 %, carbohydrate 12.1 %, mineral matter 3 %, fibre 3.8 %, calcium 279 mg /100 g, phosphorus 528 mg/100 g, iron 8.5 mg/ 100 g, thiamine 0.69 mg/100 g, riboflavin 0.53 mg/100 g, niacin 1.5 mg/100 g and vitamin C 5 mg/100 g. The clorific value of kernel is 650 k-cal/100g. The kernel also contains 34-47 % oil (Gopalan, 2).

Origin and Distribution

Chironjee, originated in the Indian sub-continent, is found growing naturally as wild stand in the tropical deciduous forests of north, western and central India mostly in the states of Madhya Pradesh, Bihar, Orissa, Andhra Pradesh, Chhattisgarh, Jharkhand, Gujarat, Rajasthan and Maharashtra. This is found growing throughout India, Burma and Nepal (Hemavathy and Prabhankar, 4). Its distribution has been marked upto an elevation of 1200 m in subtropics and up to 900 m in Sub-Himalayas. Besides India, the plants are found distributed in other tropical Asian countries, Australia and pacific islands too. About seven species have been reported from India of which two yield edible fruits. It is a common

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associate of Sal (*Shorea robusta*), Teak (*Tectona grandis*) Dhok/Kaldhi (*Anogeissus pendula*), Salai (*Boswellia serrata*) forests and occupies lower to middle canopy in dry deciduous forests.

Taxonomy

Chironjee (*Buchanania lanzan*), belongs to family Anacardiaceae, is a medium-sized deciduous tree, growing to about 50 ft tall. It bears fruits each cotaining a single seed, which is used as an edible nut. It has tickly leathery leaves which are broadly oblong, with blunt tip and rounded base. Leaves have 10-20 pairs of straight, parallel veins. The tree sheds its leaves for a very short period during May-June under subtropics. Pyramidal panicles of small bisexual greenish white flowers appear in auxiliary and terminal panicles during early spring in January-March. A single panicle bears about 3000 – 5000 flowers. When buds start growing externally, it takes about 18-28 days to anthesis. Fruit set is around 3 per cent. Fruits ripen during April and they continue to ripen till May. At ripening stage pericarp of fruits changes its colour from green to dark tan. Fruits remain on the tree for quite longer. Fruits are drupe, ovoid or globose, black, 8-12 mm in diameter with hard stones. Unripe fruit are green in colour.

Area and Production

Chironjee is not cultivated as regular plantation. It is found growing as stray plantation in natural habitat. However, its regular plantation is seen under some botanical graden. Exact statistics as regard to area is not available. However, density of population across various forest range, gives an idea as regard to plant stand and the production. In Lalitpur (U.P.) forest ranges the density of *Chironjee* plants recorded was 4.5 to 23.66 tree/ha. Tewari *et al.* (18) reported relatively higher plant population of *Chironjee* near water sourses. Similarly, Prasad and Pandey (7) reported a density of 4 to 23.66 tree/ha in teak dominant forest of Seony (M.P.) and concluded that the density of plants was greatly influenced by its vicinity to habitation. Prasad and Bhatnagar (8) reported that in Madhya Pradesh and Chhattisgarh alone, *Chironjee* seeds to the tune of 1108 tonne/year were collected.

Soil and Climate

Chironjee is commonly grown in forest area mostly in eroded ravine lands. It doesn't found growing in waterlogged areas, but occurs locally in clay soils. It prefers soils which are neutral in reaction and medium to deep in depth. In its natural habitat, it withstands absolute maximum shade temperature upto 45°C and minimum 1°C. Annual precipitation of 750 mm to 12150 mm suffices the need of crop. The plant prefers dry sub-humid climate. The plant is susceptible to frost injury.

Species and commercial varieties

Seven species of *Buchanania* have been reported in India of which two *B. lanzan* (Syn. *B. latifolia*) and *B. axillaries* (Syn. *angustifolia*) produce edible fruits. *B. lanceolata* is an endangered species. It is found in the evergreen forests of Kerala. *B. platyneura* is found in Andaman only. Other species of the genus are *B. lucida, B. glabra, B.accuminata.* It is reported that the fruits of *B. platyneura* are also edible. The B. exillaris are reported to be dwarf in size and produces excellent quality of kernel.

Variety

There is no identified cultivar of *chironjee*. Attempt is in progress to identify and release some high yielding, dwarf and suitable selections of *chironjee.* As a part of improvement, collection and evaluation, fifteen genotypes were evaluated for various horticultural traits at Central Horticultural Experiment Station, Godhra (Gujarat) and CHESC-7 was found promising. In this type, peak flowering was observed during first week of February and fruit set was noticed during third week of February. The fruit ripened during third week of April.The fruit had 1.20 g fruit weight, 22 % TSS, 13 % Total sugar, 50 mg/ 100 g vitamin C, 0.12 g kernel weight and 30.0 % kernel protein (Singh *et al.,* 12).

Propagation

The tree is propagated from seeds which remain enclosed inside a hard shell. To get better germination, the shell of the fruit should be cracked carefully .Fresh seeds give better germination. By using such seeds 70 % germination has been reported (Srivastava, 14). Singh et al. (13) reported that one kg weight of *chironjee* contains 4300-5300 seeds. The seeds have 55-65% germinability. The seed is recalcitrant in nature and they lose viability soon even after 3 months of haresting. Fresh seeds give good germination. Seed, exposed to hot sun quickly lose viability and germination is low. Shukla and Solanki (9) reported that 48-hour seed soaking in ordinary water gave as high as 71 per cent seed germination, Mechanical breaking of stony endocarp resulted in 83 per cent germination. However, mechanical breaking is time consuming and posses high risk of damage to embryo. Seed can be stored in air tight containers upto one year. Choubey *et al.* (1) reported best germination with 1 per cent HgCl treatment.Vegetative propagation through soft wood grafting and chip budding is successful but rarely tried as no demand of plants has been generated in want of commercial cultivation.

Vegetative propagation

Chironjee is hard to root. In a study, Singh *et al.* (11) reported 67 per cent rooting in root cuttings of *Chironjee* with 1600 ppm IAA treatment. Best rooting was reported from 1.5-3.5 mm thick roots. Air layering and patch budding didn't produce successful results (Tewari and Bajpai, 15). Chip budding in the month of August showed promise (Shukla *et al.,* 10). Tewari *et al.* (19) reported veneer grafting successful for propagating chironjee in the month of August -September.

Planting

Chironjee should be planted at a spacing of 8-10 metre. Seedlings tree may be planted at a spacing of 10 x 10 m and those vegetatively prpopagated ones at a spacing of 8 x 8 m. Before planting the pit should receive 20 kg FYM, 300 g super phosphate and 200 g muriate of potash. Planting on barren land leads to less survival of plants (Prakash, 6; Tewari *et al.,* 16).

Tree architecture and Pruning

Chironjee is not pruned regularly. It doesn't tolerate the rigour of regular pruning. When pruned, gum exudation starts. It further restricts pruning. The species is a moderate light demander and hence doesn't require regular pruning. However, while pruning dead, damaged, diseased and interlacerating branches should be removed. The main stem of the plant should be maintained free of branches for about 60 cm from ground level. Above it 4-6 scaffold branches scattered in all four directions are allowed to grow.

Nutition and water management

There is need to standardize nutritional requirement of *chironjee* tree. However, Srivastava (14) observed the use of 20-30 kg FYM and 100-500 g urea beneficial for the tree before flowerig stage. After flowering stage the plant should be fed with FYM 30 kg, N 400 g, P 400 g and K 600 g/plant. The plant is grown mostly as rainfed. However, for better growth regular irrigation is required.

Harvesting and Yield

The fruits of *chironjee* mature in 4- 5 months. They are harvested during April- May. At the time of maturiy fruits change their colour from green to purple. Ripening starts from proximal end of fruit. As soon as one or two drupes change colour, the fruits are considered ready to harvest. Manual harvesting is done. The branches are shock to force the fruit to drop to collet the fruits. Fruit bearing shoots (peduncle) is harvested with a sickle attached to a long bamboo pole. If this is not done carefully, there is damage to the growing shoot of plant and this is damaging to chironjee.

Yield depends upon growth of plant. Generally, a full grown plant may produce 1.0 q fresh fruits with a bulk yield of 40 kg stones and 7-8 kg kernels in a year. However, 3-4 kg kernels per

plant per year is normally harvested (Tewari *et al.,* 17). *Chironjee* has long gestational period. Exact age of bearing of *Chironjee* has yet not been established. It is believed that it takes about 15-18 years to come into bearing.

Processing

Kumar *et al.* (5) has standardized the traditional method for processing *chironjee* fruits and kernels. There are following three steps for its processing.

De-skinning

The harvested nuts are soaked overnight in water. They are then rubbed with palm and with jute sack for large scale procesing. The water containing fine skin is decanted. To get clean nuts, they are washed in clean water. The clean nuts are dried in sun for 2-3 days and stored for shelling.

Shelling

It is the process of separating kernel from hull. For small scale processing, the dried nuts are rubbed using stone slab on a rough stone surface. The kernels are then manually separated. However, for large scale shelling horizontal stone under runner or burr mill is used. The impact and arasive forces separate coat from kernel and split the kernel.

Grading

This is done to separate kernels from hulls and also to separate kernels of different sizes. The shelled or splitted keranels are passed through a grader. The graders are fitted with three oscillating screens of various sizes. The grader separates the produce as per its opening size.

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Research Note :

EFFECT OF $AgNO_3$ AND 8-HQC ON VASE LIFE OF CUT ROSES

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Keywords: *Cut Rose, 8-HQC, $AgNO_3$, vase life.*

Flowers form an integral part of our rich heritage and culture as we have tradition in floriculture. In the last two decade with changing life styles and rapid urbanization, floriculture has assumed a definite commercial status in India. In India roses are grown for cut flowers, making essential oil, rose water and *gulkand*. First Red and Grand Gala both are the important cultivars of cut rose. 8-hydroxy quinoline citrate (8-HQC) is a very important and effective germicide used in floral industry (Butt, 1). Thus, incorporating 8-HQC either in vase solution or as pulse would restrict the microbial growth and subsequent vascular blockage and thus promote water uptake.

But very little work has been done to prolong the vase life of cut roses and still lot needs to be done. None of the workers has suggested clear-cut recommendation about chemicals and their concentration for adoption to the vase life of cut roses. Keeping the above fact in view, an investigation was carried out to study "effect of $AgNO_3$ and 8-HQC on vase life of cut roses" during July 2010 in the laboratory of Department of Horticulture, Ch. Charan Singh University Campus, Meerut (U.P.) India.

The cut flowers having 42-44 cm stem length were harvested in the morning between 7.00 am to 8.00 am at tight bud stage, when only one or two petals had unfolded, with the help of a clean and sharp secateur. The cut flowers were then brought to the laboratory in a bucket containing fresh tap water. The stem ends were then re-cut to uniform length of 40 cm each and retained only four uppermost leaves.

After recording the fresh weight of each cut stem in the laboratory the cut flowers were kept in 50 ppm and 100 ppm solution of $AgNO_3$ and 100 ppm and 200 ppm 8-HQC under ambient condition of 32 ± 2°C temperature and 50-75% relative humidity. There were ten treatments in all, each cultivar having four and two was of control, replicated thrice in completely randomized design (CRD) and the flowers taken per replication were four and finally the vase life and quality of cut roses were evaluated in the test tubes containing of 150 ml holding solution.

Vase life in days was counted from the time when the cut flowers were kept in vase till senescence. The end of useful vase life or senescence symptoms was marked either by appearance of bent neck, bluing of petals in case of the flowers, wilting, blackening or drying of outer petals or opening at centre petal drop and colour fading etc.

The use of 8-HQC is well known in cut flowers as it acts as an bactericides for improving the vase life of cut rose, while $AgNO_3$ which acts as an anti ethylene also helps in enhancing the flower diameter and vase life of cut roses. Treatment with $AgNO_3$ (50ppm) and 8-HQC (200 ppm) significantly increased the fresh weight of flowers over the control (distilled water). Higher gain in fresh weight was associated with longer vase life. Initial increment of fresh weight until 3rd day after harvest was also observed by Shiva and Bhattacharjee (4). Pulsing or holding solution increases the total starch content of the petals over the untreated control as starch content was positively associated with vase life as obtained by Mariam *et al*. (3). Solution containing 8-HQC limits the number of bacteria in stems. Similarly, effect of $AgNO_3$, which is also an antiethylene agent, enhance the flower diameter and water

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Table 1: Effect of $AgNO_3$ and 8-HQC on vase life of cut roses.

Treat-ments	Concen-trations (ppm)	Fresh weight change (g)						Flower diameter (cm) on 3rd day in vase		Water uptake (ml)				Vase life (days)	
		Fresh Weight		At senescence		Grand Gala				on 3rd day in vase		At senescence			
		cv.		cv.		cv.				cv.		cv.		cv.	
		First Red	Grand Gala	First Red	Grand Gala	First Red	Grand Gala	First Red	Grand Gala	First Red	Grand Gala	First Red	Grand Gala	First Red	Grand Gala
$AgNO_3$	50 (T_1)	14.71	16.5	+ 1.83	+ 1.72	- 0.64	- 0.73	8.19	6.65	10.54	9.60	11.17	10.35	8.70	7.60
	100 (T_2)	14.32	16.71	+ 1.45	+ 2.29	- 1.03	- 0.62	7.92	6.93	8.27	8.78	19.83	12.55	8.32	7.36
8-HQC	100 T_3	12.05	13.29	+ 2.75	+ 2.30	- 0.64	- 1.08	8.58	6.62	12.53	11.22	19.45	17.25	9.79	7.89
	200 T_4	13.61	13.29	+ 3.55	+ 2.40	- 0.69	- 1.21	8.24	6.82	21.86	12.73	27.51	17.25	9.55	7.50
Control	Distilled Water T_5	11.45	15.2	+ 2.41	+ 2.10	- 1.44	- 0.99	6.27	5.78	9.77	8.85	19.14	10.02	5.35	4.25
C.D (P=0.05)		0.123	0.275	0.073	NS	0.040	0.033	0.041	0.061	0.151	0.042	0.274	0.097	0.186	0.096

uptake of cut rose cv. 'First Red' and cv. 'Grand Gala.'

Doorn *et al*. (2) reported enhancement in vase life of cut roses blooms treated with $AgNO_3$ and 8-HQC. Further experiment conducted on rose cv. 'First Red' and 'Grand Gala' presents enhanced water uptake and flower diameter over control. In the experiment vase life of cut flower under different treatments was determined in vase holding solution *i.e.,* 50 ppm, 100 ppm, $AgNO_3$ and 100 ppm, 200 ppm 8-HQC.

The cut rose cv. First Red showed the maximum diameter at 100 ppm 8-HQC, while as in cv. Grand Gala 100 ppm $AgNO_3$ showed maximum flower diameter on 3rd day in vase. The maximum vase life of cut roses cv. First Red and Grand Gala was recorded in 8-HQC at 200 ppm and 100ppm. The above findings shows that the chemical response of $AgNO_3$ was best for increasing the fresh weight of cut flowers, while as the maximum vase life of cut flowers were recorded when treated with 8-HQC which act as bacteriocide and improves the flower diameter, water uptake and vase life of cut rose flowers. However, the comparison or varietal difference was found to be best in cv. First Red in comparison to cv. Grand Gala in terms of its fresh weight (g), flower diameter (cm) and vase life.

From the results obtained (Table 1) it can be concluded that holding the cut rose cv. First Red and cv. Grand Gala in the solution of 8-HQC at 200 ppm was most effective in promoting the fresh weight and water uptake cut rose of flowers.

The cut rose cv. First Red and Grand Gala treated with $AgNO_3$ and 8-HQC at 100 ppm and 200 ppm increased the flower diameter, however, the maximum flower diameter was recorded in cv. First Red at 100 ppm 8-HQC, while in cv. Grand Gala maximum diameter was recorded at 100 ppm $AgNO_3$. The keeping quality of cut rose, treated with $AgNO_3$ and 8-HQC chemicals showed better results at 100 ppm 8-HQC in which maximum vase life was obtained in cv. First Red and in also in cv.

Grand Gala in comparison to control confirming to results of Son *et al.* (5).

Form the experimental findings, it was observed that cv. First Red has more vase life in comparison to cv. Grand Gala. It is concluded from investigation that 8-HQC enhances the fresh weight, flower diameter, water uptake and vase life of cut roses at 100 ppm and 200 ppm.

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Research Note :

MORPHOLOGICAL MARKERS FOR IDENTIFICATION OF *Populus deltoides* CLONES IN NURSERY

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Poplar (*Populus deltoides*) is a multiutility wood producing tree species and has been widely adopted under agro-forestry systems because of its fast growth, straight and clean bole and deciduous nature. Many genetically improved poplar clones have been developed for growing in North-Western part of India. However, there is problem to distinguish these clones phenotypically because of narrow genetic base of parents in breeding population and their multiplication. This problem of identification for purity of planting stock becomes more immense for a grower when he wishes to plant a specific clone. To overcome the problem an endeavour was taken to establish morphological marker for identification of ten widely grown clones of poplar.

Ten poplar clones namely G3, G48, S7C1, S7C4, S7C8, S7C20, L34, PP5, Fierelo and D121 were planted in nursery block of Agroforestry Research Centre, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, in a randomised block design with three replications. Each replication contained two row of each clone at 80 cm apart and each row had ten plants at 60cm distance. Observations were recorded for qualitative (leaf shape, leaf pigmentation, leaf serration, leaf tip type, ridge line, ridge shape) and quantitative (bud length, bud diameter, number of buds and internodal length) traits. Qualitative characters : leaf shape was recorded on the basis of curve in leaf lamina and attachment of petiole on scale 'A'-deep curve and 'B'-light curve. Leaf pigmentation was noted on scale 'A' (pigmentation on petiole and midrib), 'B' (pigmentation on petiole at the point of attachment of leaf lamina) and 'C' (no pigmentation). Leaf serration studied on scale 'A' (full serration) and 'B' (partial serration). Leaf tip type was observed on scale 'A'-long tip and 'B'-small tip. Ridge line (bulging and length) was recorded on scale very prominent prominent and less prominent. Ridge shape on the stem was observed on scale 'A'-big ridge and 'B'-small ridge. Quantitative characters namely bud length (mm), bud diameter (mm), number of buds in one metre length at middle of stem and internodal length (cm) were recorded on five competitive plants in each replication and averaged.

Results on comparison of various morphological characters in ten prominent clones are presented in Table 1. Clone G3, S7C4, S7C8, L34 and D121 were showed similar kind of leaf shape 'B' while clones G48, S7C1, S7C20, PP5 and Fierelo showed 'A' type leaf shape. Clone S7C8 and G3 had type 'A' and 'B' pigmentation, respectively, other clones showed no pigmentation. All studied clones showed similar kind of leaf serration. A type of leaf tip was observed in clone G3, S7C4, S7C8, S7C20, L34 and PP5 while 'B' type leaf tip was found in G48, S7C1, Fierelo and D121. Bud length ranged from 3.12 mm (Fierelo) to 3.80 mm (S7C4) and bud diameter varied from 2.95 mm (G48) to 4.08 mm (G3). Maximum number of buds per metre stem length were observed in G48 and S7C20 while minimum buds were counted in D121. Similar fashion of ridge shape was observed in all the clones. Very prominent ridge was found in clone S7C4 while other clones have prominent ridge. Internodal length ranged from 3.38 cm in clone S7C1 to 4.25 cm in clone L34. Similarly Sidhu *et al.* (2) observed significant morphological differences for

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Table 1: Morphological marker on the basis of leaf and stem characteristics of *Populus deltoides* in nursery.

Clone / Traits	G3	G48	S7C1	S7C4	S7C8	S7C20	L34	PP5	Fierelo	D121
Leaf shape	B	A	A	B	B	A	B	A	A	B
Leaf pigmentation	B	C	C	C	A	C	C	C	B	C
Leaf serration	A	A	A	A	A	A	A	A	A	A
Leaf tip	A	B	B	A	A	A	A	A	B	B
Bud length (mm)	3.25	3.16	3.50	3.80	3.77	3.65	3.15	3.20	3.12	3.61
Bud diameter (mm)	4.08	2.91	3.85	3.95	4.06	4.05	3.50	3.45	3.38	3.94
No.of buds in 1 m stem at middle	21.40	22	21	23	20	22	21	18	20	17
Ridge shape	same	same	same	same	same	same	same	same	same	same
Ridge line	Prom-inent	Prom-inent	Very Prom-inent	Prom-inent	Prom-inent	Prom-inent	Prom-inent	Prom-inent	Prom-inent	Prom-inent
Internodal Length (cm)	3.75	4.20	3.38	3.89	4.02	3.80	4.25	3.80	3.81	3.50

intermodal length, branch angle, lenticels density length of ridges, leaf length and width and petiole length among seven clones. Genetic differences for leaf characteristics were also observed by Guzina (1). Morphological and phenological description of poplar clones based on 64 characters of young to adult tree was given by UPOV (3).

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